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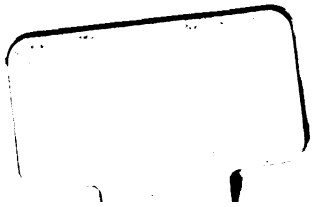

1874 Eng 838.80.3

TEXAS AND PACIFIC

RAILWAY COMPANY.

REPORT

OF

GEN. G. M. DODGE,

Chief Engineer.

1874.

NEW YORK:
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REPORT

OF

GEN. G. M. DODGE,

CHIEF ENGINEER.

TEXAS AND PACIFIC RAILWAY COMPANY,

CHIEF ENGINEER'S OFFICE,

MARSHALL, TEXAS, May, 1874.

COL. THOMAS A. SCOTT,

PRESIDENT TEXAS AND PACIFIC RAILWAY:

SIR:—The charter of the Texas and Pacific Railway Company as granted by the United States, provides for the construction of a continuous railroad and telegraph line from Shreveport, Louisiana, by Marshall, Harrison County, Texas, thence by the most direct and eligible route, to be determined by the Company, near the thirty-second parallel of north latitude to a point at or near El Paso, thence by the most direct and eligible route, to be selected by said Company, through New Mexico and Arizona to a point on the Rio Colorado, at or near the south-eastern boundary of the State of California. Thence by the most direct and eligible route to San Diego, California, to ship's channel in the State of California, pursuing in the location thereof, as near as may be practicable, the thirty-second parallel of north latitude.

This charter also provides for the construction of a railroad from Fort Yuma to San Francisco, not limiting us from taking the most economical advantages of the topography of the county, in leaving our main line.

It requires that 100 miles each year shall be completed from its eastern terminus, and 10 miles from its western terminus by May, 1874, and after that 25 miles per year from its western terminus until the two lines meet. The rate at which the line is to be built from its eastern end is materially modified by its charter in Texas, which is more fully explained in a subsequent part of this report.

As far as possible we consider the question connected with the construction of the road as follows:

1st. Location of Lines.
2d. Connections.
3d. Water Supply.
4th. Timber.
5th. Fuel.
6th. Ballast.
7th. Building Stone.
8th. Agricultural Resources.
9th. Mineral Resources.
10th. Land and Town Lots.
11th. Earnings.
12th. Commercial and Military Value.

You will also find, in a condensed form, estimates of cost of construction and equipments; table of grades, summits and distances, and comparison with other trans-continental lines. Annexed will be found reports of Engineers in charge of the different divisions, with copies of the instructions under which they acted.

DIVISIONS.

For Surveys and Construction. The whole line was divided into 5 divisions.

1. *Construction East of Fort Worth.* In charge of Captain R. S. Hayes.

2. *Brazos Division.* From Fort Worth to a point a little

west of the 100th meridian, and south of Double Mountain, in charge of Messrs. Hodges, Wilson and O'Neill.

3. *The Pecos Division.* From the Brazos Division to Fort Bliss, or El Paso, on the Rio Grande, in charge first of Mr. E. D. Muhlenburg, and finally in charge of Major M. F. Hurd.

4. *New Mexico Division.* From the Rio Grande to the Pima Villages on the Rio Gila, in charge of Mr. George Wolcott.

5. *California Division.* From the Pima Villages to San Diego, California, in charge of Mr. J. A. Evans.

EXTENT OF SURVEYS.

To develop the country in detail on or in the vicinity of the thirty-second parallel of latitude, a belt of country 200 miles wide and 1,900 miles long was thoroughly explored, 10,000 miles of instrumental line run, and 15,000 miles of reconnoissance made from July 1st, 1872, to January 1st, 1874, at a cost of $500,000.

For the detailed information as to the line, I refer you to the reports attached hereto.

ROAD IN TEXAS.

In the State of Texas, three divisions of the Texas and Pacific Railway have been placed under construction.

1. Southern Division, Shreveport to Fort Worth, 219 miles.

2. Trans-continental Division, Texarkana to Fort Worth, 236 miles.

3. Jefferson Division, Marshall to Texarkana, 69 miles.

TEXAS CHARTER.

The charter granted by the State of Texas requires the completion of the road:

1. From Marshall to Texarkana, its junction with the St. Louis, Iron Mountain and Southern Railway, by January 1st, 1874.

2. From Texarkana to Sherman, Trans-continental Division, and from Longview to Fort Worth, on Southern Division, by July 1st, 1874.

3. From Sherman to Fort Worth, Trans-continental Division, by January 1st, 1875.

In July, 1872, when the present Company entered upon the work, the road was in operation from Shreveport to Longview, a distance of 66 miles.

The Company not only intended to build a railroad to the Pacific, developing the country adjacent to the thirty-second parallel of latitude, but to construct its eastern divisions, that is, two lines diverging from Fort Worth to the east. It would connect the Pacific Coast and the territories through which the line passed, with the manufacturing and commercial centres of the north, east and south, by the shortest, most direct and practicable route.

By them we reach St. Louis from Fort Worth, via the Trans-continental Division and the St. Louis, Iron Mountain and Southern Railway, in 745 miles. Chicago, by same route, to Poplar Bluff, thence by Cairo and Illinois Central Railroad in 998½ miles. To New York, via Sherman, Texarkana, Little Rock, Memphis, Louisville, Cincinnati and Pittsburgh, 1,756 miles, or to New York, via Shreveport and North Louisiana Railway, to Vicksburgh, and thence by central southern lines to New York, 1,653 miles. By same route to Richmond, Virginia, 1,386 miles, and to Washington, D.C., 1,468 miles. To Galveston, by Dallas and the Texas Central Railroad, 345 miles, or via Minneola and the Great Northern Railroad, 399 miles, and to New Orleans, via Shreveport and Red River, or via Shreveport, Vicksburgh and Mississippi River, or via contemplated route through Louisiana via Marshall, Donaldsonville and Vermillion.

The Jefferson Division from Marshall to Texarkana, with its connections, also gives a direct route from Galveston, Houston, San Antonio, Austin, and south-eastern Texas, via the International and Great Northern to the north and north-west, distance from Galveston to St. Louis, 875 miles.

In addition to these advantages, the three divisions, forming the three sides of a triangle, with its least angle at Fort Worth, develops the richest and best settled portions of north Texas, a country heretofore without transportation facilities, but

abounding in everything required for a numerous and wealthy population.

CONSTRUCTION.

The original charter from the State of Texas required that we should complete the whole road to Fort Worth by January 1st, 1874, and the efforts upon the part of the Company to comply with the charter, and complete over 500 miles of road within one year, required an enormous expenditure of money.

The three divisions east of Fort Worth, 525 miles, was estimated to cost $12,363,129, and was under charge of Capt. R. S. Hayes, as Engineer in charge of construction. Mr. J. M. Eddy, Assistant Superintendent, being in charge of transportation, supplies and material.

The report of Capt. Hayes is herewith submitted, giving full details of the work from August, 1872, to February 1st, 1874.

COMPLETED ROAD.

Southern Division,	Longview to Dallas	124	miles.
Jefferson "	Marshall to Texarkana . . .	74	"
Trans-cont'l "	Sherman to Brookston . . .	58	"

256 miles have been completed and accepted by the State of Texas and by the United States as a first-class road, complying with all the requirements of the charter and laws of Texas, and with the acts of Congress.

107 miles additional have been graded, tied and bridged ready for the iron, and in addition to this, 66 miles of road have been partially rebuilt; ties, bridges, buildings, depots and tanks renewed, and the gauge changed from 5 feet 6 inches to 4 feet 8½ inches.

Over $9,000,000 have been disbursed in completing this work without any loss to the Company, and within the amount of the estimate first submitted, although they did not then contemplate the extraordinary outlays rendered necessary by the lack of navigation in Red River, or the delay of the completion of the connecting roads, the epizoötic, and finally the yellow fever, which quarantined us for ninety days.

This large expenditure of money in so limited a time, forced upon us by the State Legislature, rendered the undertaking a

difficult and serious one. Up to the time of the financial panic, our organization and progress had assured us that we would be able to comply with the requirements of our charter.

Had we been in railroad communication with St. Louis and Galveston in the fall of 1872, as was promised, instead of the spring of 1873, or could we have relied upon the navigation of Red River, as we had a right to expect from the experience of former years, say from November, 1872, to March, 1873, our line would have been completed to Dallas and Sherman by January, 1874, and our construction well advanced from Dallas to Fort Worth. Notwithstanding these drawbacks, we built more road during the year than any other company in the United States.

The three divisions, as soon as completed, will earn at least $5,000 per mile per annum, and as the country fills up, the earnings will gradually and permanently increase.

The eastern part of the State through which the line runs, is heavily timbered with pine, oak and cypress. The western portion is prairie. The local demand for lumber in the West the return transportation of cattle, cotton and grain East, and the passenger traffic over it in every direction, covering as it does by its connections the whole of the thickly settled portion of Texas, will give this part of the line when completed and equipped a very large, remunerative and increasing trade The completed road is a first-class new railroad, substantial in all its parts, and fully equal to any of the roads of the Western States.

The bridges, shops, water stations and depot buildings are ample and substantial, far exceeding its present wants. The equipment is new and from the best shops.

To complete it to Fort Worth as required by law, it will be necessary to lay track, erect water stations and buildings on the graded, tied and bridged portion of the Trans-continental Division from Texarkana to Brookston, a distance of 94 miles, by July 1st, 1874, and the building of 27 miles of new line from Dallas to Fort Worth by July 1st, 1874, also the construction of the line from Sherman to Fort Worth by January 1st, 1875, distance 81 miles, and thereafter each year not less than 100 miles on the Texas end, and 25 miles on the California end of the line each year until completed across the continent.

There is now before the Legislature of Texas a bill granting all roads one year's extension of time. Should it pass, it will add an additional year to the time above stated.

In the fall of 1873, in accordance with the law of the United States, work was commenced at San Diego, California, under the supervision of Mr. James A. Evans, Division Engineer, 10 miles of work was let—at this time the grading, bridging and tieing is nearly completed. This work is still progressing, and we hope within the next ninety days to have it ironed and equipped.

Nearly all of our arrangements, right of way matter, real estate, etc., at San Diego, have been satisfactorily settled, and work should be commenced as soon as practicable in the tunnel upon the next section of 35 miles. To work this tunnel economically, we should have at least twelve months in which to complete it.

DESCRIPTION OF ADOPTED LINE.

The Texas and Pacific Railway will extend from Shreveport, Louisiana, on Red River, to San Diego, California, with a branch from Marshall, Texas, to Texarkana, there connecting with the St. Louis, Iron Mountain and Southern Railway, and from Texarkana through Paris and Sherman, connecting with the main line at Fort Worth.

Over this route the surveys have determined that in an engineering and commercial point of view, the line to be adopted is as follows:

Leaving Shreveport the road runs almost due west through Caddo Parish, Louisiana, and through the Counties of Harrison, Gregg, Upshur, Wood, Smith, Van Zandt, Kaufman, Dallas, and Tarrant in Texas, passing through the towns of Marshall, Hallville, Longview, Willow Springs, Gladewater, Hawkins, Minneola, Grand Saline, Wills Point, Elmo, Terrell, Forney, Mesquite and Dallas to Fort Worth at the junction of the West and Clear Forks of Trinity River in Tarrant County.

This line crosses the divide between Red River and Sabine River, and runs up the valley of the Sabine, crossing it in Van Zandt County, crossing the Trinity River at Dallas, following the West Fork of the Trinity to Fort Worth. Distance, 219 miles.

Fort Worth to San Diego. Commencing at Fort Worth, the line follows the valley of the Clear Fork of the Trinity in a south-westerly direction to the mouth of South Fork, and up the valley of South Fork to its head ; passing through Weatherford, the county seat of Parker County, and thence north-west crossing the headwaters of numerous tributaries of the Brazos, passing into Palo Pinto County about four miles from the north-east corner. It then turns a little south of west, and crosses the Brazos River near the mouth of Cedar Creek, and follows up the valley of Veals Creek, and across the divide into the valley of the Clear Fork of the Brazos, and then following the general course of the Clear Fork to the south-east extremity of the big bend of the Clear Fork, about four miles south-east of Fort Griffin, thence following up the valley of Trout Creek to its head, and down one of the tributaries of Clear Fork, it crosses Clear Fork about four miles south of the north line of . Shackleford County. Thence almost due west, crossing California Creek on the west line of the same county and following its valley to its head, and thence in a direct line south-west, on the divide between the waters of Clear and Double Mountain Forks of the Brazos to a point 18 miles south of the Double Mountains, a distance of 210 miles.

From this point the line runs a little south of west, crossing the headwaters of the North Fork of the Colorado, and between Muchaque and Solitaire Mountains to Sulphur Springs—Latitude 33.30, Longitude 101.45 W., on the east border of the Staked Plains a distance of 75 miles—thence south-west crossing the Staked Plains to the Rio Pecos, crossing this river about 15 miles above the mouth of Toyah Creek, and 54 miles below the mouth of Delaware Creek, 119 miles; thence a little south of west in a very direct line to the newly discovered pass in the Gaudaloupe Mountains, known as Hurd's Pass—latitude 32.30 longitude 104.30 W.—62 miles. This pass is about 40 miles south-east of the Guadaloupe Pass; thence north-west and parallel to the Guadaloupe Range, 48 miles to a point in Salt Lake Valley, 25 miles south-west of Gaudaloupe Pass; thence almost due west crossing the Heuca Mountains, through a low pass to Fort Bliss on the Rio Grande.

From there the line follows up the valley of the Rio Grande for a distance of 38 miles to near the town of Mesilla, then turning almost due west ascends to the table-lands of the Sierra Madre, which is reached in a distance of 6 miles, and on the same course crossing the high rolling prairie of the Sierra Madre, it passes through the Florida Pass, between Fort Cummings and the Florida Mountains, into the valley of the Miembres, crossing that river about 12 miles south of Ojo de Vaca (Cow Springs) and about 35 miles south of Fort Bayard, Silver City and the Lone Mountain Mining District. We leave the Burro Mountains on the north, the Pyramid Range on the south, and passing near the Rallston Silver Mines we reach the valley of Playas, 125 miles west from the Rio Grande. After crossing this valley we pass the Peloncillo or Stein's Peak Range, through a low gap about 6 miles south of Stein's Peak, and the old Boundary Commission Road. The line then crosses the San Simon Valley in a direct course for Railroad Pass, in the Chiricahiu Mountains, thence south-west across the Valley of Playas de Los Pinos, and across the Caliuro Mountains by way of Nugent's Pass, which is north of and about 10 miles from Dragoon Pass, thence to the valley of the San Pedro, near the settlement of Tres Alamos, thence south and up the San Pedro about 5 miles, thence west to the Cunega Pass, between the Whetstone Mountains on the south and the Santa Catalina Mountains on the north, and 20 miles north of Fort Buchanan summit, which is the highest point between the San Pedro and the Gila, thence north-west down the valley of the Cunega and Rillito to near the town of Tucson, following down the valley of Santa Cruz, keeping near the old stage route *via* the point of mountains to near Desert Station, then leaving the valley of Santa Cruz, and passing north of the Picacho Mountain, we again strike the valley near Picacho Station, and follow it about 20 miles, thence through a valley to the Gila, near Sacaton, and about 60 miles below the mouth of the San Pedro, and down the valley of the Gila 12 miles to the Pima Villages, and following the Gila to its junction with the Colorado of the West at Fort Yuma, cutting off the great bend of the Gila by a direct natural route through St. Valentine's Pass. From there the line runs in a north-westerly direction, passing to the north of the Sand

Hills and across the Salt Lake district of the Colorado Desert of California, over which our line for 45 miles is below sea level, the lowest point being 290 feet below tide water. In crossing this the line passes on the north margin of the Salt Lake of the Colorado Desert, leaving the mud volcanoes about 5 miles to the south, and the Des Palmos stage station about the same distance to the north, we reach the Cabazon Valley 113 miles from Fort Yuma. Thence, on nearly the same course, 50 miles, to the summit of San Gorgonio Pass running $1\frac{1}{4}$ miles south of Whitewater Stage Station and 1 mile south of Devontine's Ranch, reaching the summit $2\frac{1}{2}$ miles south of Edgar's Ranch. This Pass is 2,621 feet above tide water, and its small elevation must be considered remarkable, as it lies between the San Bernardino and San Jacinto Mountains, the highest peaks of the range. Leaving San Gorgonio Pass our course is south-west, passing down one of the tributaries of the San Jacinto, which is known as the Potnero (or Pocket) of the San Jacinto, to the San Jacinto Plains and Temecula Plains—these plains lie between the main range and the Santa Anna range—and down the Temecula Plains to the head of Temecula Cañon, and down the Cañon where the Temecula breaks through the Santa Anna range 10 miles to the open valley, striking the coast near the Santa Marguerita Ranches, about 40 miles north of San Diego. Thence south and down the coast on the western slope of the Soledad Mountains, crossing the Soledad, San Louis Rey, San Dieguito and the ravine of La Jolla, skirting False Bay, thence to the shore of San Diego Bay, and along the shore of the bay to the depot grounds of the Texas and Pacific Railway, below the Pacific Steamship Company's wharf. Distance from the Pima's Villages on the Gila River 444.4 miles.

Fort Worth to San Diego, ...	1,457.64 miles.
Shreveport to San Diego, ...	1,676.64 "
Texarkana to San Diego, ...	1,693.63 "

In addition to the main line from Shreveport to San Diego, the Texas and Pacific Railway have

THE JEFFERSON DIVISION,

which leaves the main line at Marshall, 40 miles west of Shreve-

port, and runs north through the Counties of Harrison and Marion to Jefferson, and thence a little east of north through the Counties of Cass and Bowie to the Trans-continental Division, at a point 5 miles west of Texarkana, passing through the towns of Woodlawn, Jefferson, Kildare, Atlanta, Lanark and Moore's Landing. Length of Jefferson Division proper, 69 miles. Distance from Marshall to Texarkana, 74 miles.

THE TRANS-CONTINENTAL DIVISION.

From Texarkana, on the line between Arkansas and Texas, the line runs nearly due west through the Counties of Bowie, Red River, Lamar, Fannin and Grayson to a point 5 miles west of Sherman; thence a little south of west through the west part of Grayson, the south-east corner of Cooke, and through Denton and Tarrant Counties to Fort Worth, passing through the towns of Round Prairie, Bowie, DeKalb, Savannah, Clarksville, Blossom Prairie, Paris, Brookston, Honey Grove, Dodd City, Bonham, Savoy, Sherman, Pilot Point and Denton. From Texarkana to Honey Grove it follows the divide between Red River and Sulphur; thence on the slope towards Red River to 5 miles west of Sherman; thence on the west side of the divide, between the East Fork of Trinity and Trinity Rivers, crossing Elm Fork of Trinity River east of Denton, and crossing Denton and Hickory Creeks, tributaries of the Trinity; crossing the divide between Trinity and West Fork on the north line of Tarrant County, and connects with main line at Fort Worth. Distance, 236 miles. The grades on the completed portions of the road are comparatively light and easy, following the natural contour of the country on the part graded by the Texas and Pacific Railway Company, in no case exceeding 66 feet per mile on the straight line, and correspondingly reduced on the curves. It will be seen upon examination of the table of grades that grades exceeding 66 feet to the mile are all on the old Southern Pacific, east of Longview, and on the old Memphis and El Paso grade, between Marshall and Texarkana. These can be reduced to the maximum of 66 feet to the mile at a small cost. From Fort Worth to within 8 miles of Hurd's Pass, in the Guadaloupe Mountains, the maximum grade is 66 feet per mile; approaching this pass, grades from 80 to 105 feet per mile are used for 8 miles on the east and 2½ miles on the west of the pass. The elevation of this

pass is 4,419 feet above tide water, and 1,945 feet above the valley of the Pecos, and 1,258 feet below the Guadaloupe Pass. Between the Guadaloupe and Hueca Mountains the grades are all less than 66 feet per mile; approaching the Hueca Pass a grade of 90 feet ascent for 1 mile on the east and for 15 miles on the west side of the range. Again, for 12 miles east of the Rio Grande, grades as high as 90 feet to the mile are occasionally used. It is expected that on a careful location of the line, no grade greater than 80 feet to the mile will be required in crossing the Guadaloupe and Hueca Ranges.

From the Rio Grande to Stein's Peak Range, between which points we cross the Divide of the Continent, the grades are all light, only in one case being as high as 60 feet to the mile, that extending for about 6 miles from the Rio Grande to the table-lands of the Sierra Madre.

Through the pass on Stein's Peak Range grades of 80 feet to the mile are used, but by a careful location and a small increase of cost they can be reduced to 66 feet. Across the valley of the Playos Delos Pimas the grades are light until we reach Nugent's Pass, where grades of 80 feet are used for a short distance. From there to the Pima Villages the grades will not exceed 66 feet to the mile. From the Pima Villages to the Colorado the grades are very light, generally following the natural fall of the valley.

On the California Division the grades are light, except the approach on the east side of San Gorgonio Pass. At this point grades are used up to 105 feet to the mile. The total length of maximum grade of 105 feet used on this division is 16.17 miles, and of grades of 60 feet and over, 45.29 miles. The total length of grades from 80 to 105 feet to the mile, from Texarkana and Shreveport to San Diego is 21 miles; from 66 to 80 feet per mile is 37 miles, in a total distance of 1,981½ miles of line.

CONNECTIONS.

SOUTHERN DIVISION.

At Shreveport, *via* Red River and Mississippi and all points on the Mississippi; also, *via* North Louisiana Railroad to Vicksburgh, and thence by rail to all points in the older Southern States.

At Marshall, Jefferson Division to Texarkana for all points north.

At Longview, with the International Railroad for Troupe, Palestine, Hearne, Austin, San Antonio and all points in south-western Texas; also with the International and Great Northern Railroad for Houston, Columbus, Columbia, Galveston and gulf ports.

At Minneola, with International and Great Northern Railroad for Tyler, Galveston, &c.

At Dallas, with the Houston and Texas Central, running south to Houston and Galveston, and southern and south-eastern Texas; running north to Red River, connecting with the Trans-continental Division at Sherman, and with the Missouri, Kansas and Texas Railway at Red River for the Indian Territory and Kansas, and all points north.

At Fort Worth, at present, with the El Paso Stage Line for El Paso, and all points in Mexico, New Mexico, Arizona, and the western portion of the Indian Territory, and hereafter with the Trans-continental Division for Sherman, Northern Texas and Texarkana, and the north and east; and with the proposed Fort Worth and Denver, and proposed Waco and Fort Worth Railroads. Regular trains have been running on this division from Shreveport to Dallas, 186 miles, since July 1st, 1873.

JEFFERSON DIVISION.

At Marshall, with the Southern Division Texas and Pacific Railway.

At Jefferson, with navigation on Red River.

At Texarkana, with the St. Louis, Iron Mountain and Southern Railway and Trans-continental Division of the Texas and Pacific Railway. This division forms the connecting line between our northern and southern line, and also forms a part of the shortest line from all points south and south-west of Hearne and Palestine, *via* the International and Great Northern. The Texas and Pacific and the Cairo and Fulton Railways to St. Louis, Memphis, Cairo, and all points north and east, giving a line from Galveston to New York 255 miles shorter than any other existing route.

TRANS-CONTINENTAL DIVISION.

At Texarkana, with the St. Louis, Iron Mountain and Southern Railway for all points north-east and in the Central Southern States, and with the Jefferson Division for New Orleans *via* Shreveport, and for Galveston and Southern Texas *via* the International and Great Northern Railway.

At Sherman, with the Houston and Texas Central Railway for Middle and Southern Texas and the Indian Territory, Kansas and the north-west, and with the proposed Wichita and Sherman Road, which will run nearly west, to a connection with the Atlantic and Pacific.

WEST OF FORT WORTH.

The State of Texas has granted a liberal charter to the Fort Worth and Denver Railroad, which, with the Fort Worth, Clebourne and Waco Railroad, and the Waco Tap and Central Road, which are intended to open direct communication between the Pan Handle of Texas and the States north of it, and the Gulf of Mexico. These cross our line at Fort Worth. The fertility of the country through which these lines pass and the desire of Galveston to control the trade of Texas will assure the completion of these lines at no distant day. They will form important feeders to our line, and materially shorten the distance from the western portion of our line to the Gulf. West of this will be a connection with the Atlantic and Pacific Railway. Considering the question of a connection of the Atlantic and Pacific with the Texas and Pacific upon the most practicable route, I should recommend that from Venita south-west to Red River, at or near the mouth of Big Wichita, on as direct a line as the contour of the country will allow; thence down the Wichita on the divide east of that river to the most northerly bend of the Brazos, or in its vicinity, connecting with the Texas and Pacific on the divide just south of the Double Fork of the Brazos and east of Double Mountain. This gives a direct short line to St. Louis, all of it being through a country that is susceptible of the highest cultivation, well timbered, well watered, and capable of sustaining a dense population.

It also brings us east of the range of Wichita Mountains,

and avoids the heavy country that would have to be crossed with any line striking west of Double Mountain.

It also connects with the Texas and Pacific just before it reaches the staked plains, and will avoid the building of two lines across a portion of country, the local traffic of which would be nominal. It is at present unavailable for agricultural purposes.

The distance from Venita to a connection with the Texas and Pacific, near Double Mountain, would be about 450 miles. If a shorter distance was required upon a practicable route, it could be obtained by running from the crossing of Red River, at the mouth of Little Wichita, almost directly south, via Fort Belknap, and connecting with our line south-west of Fort Griffin. The distance from Venita to a connection with the Texas and Pacific being about 350 miles.

Either of these routes would develop a portion of the Indian Territory and Texas, now without railroad facilities, and would soon build up a local traffic that would more than support the road.

The connection if made near Double Mountain at a point 425 miles west of Shreveport and 1,231½ miles east from San Diego, from the point of junction *via* the Atlantic and Pacific it would be 813 miles, and *via* the Texas and Pacific and Iron Mountain would be 936 miles to St. Louis.

At Fort Bliss (El Paso), on the Rio Grande, the Atchison, Topeka and Santa Fe Railroad will form a junction with the Texas and Pacific Railway. El Paso will be the most natural point for a junction of a road through the City of Chihuahua to the City of Mexico. Chihuahua is the Capitol of the State of Chihuahau, which is without railroad connections, and the city has a population of 15,000; the State a population of 150,000. Our road, when completed to El Paso, will command the bulk of the trade from this large population. The distance from Fort Bliss to Chihuahua is 240 miles, and to the City of Mexico a little over 1,000 miles. Near Tucson will be the initial point of a line up the valley of the Santa Cruz into Sonora, which eventually will be extended to the Gulf of California, probably at Guaymas. The mineral wealth of Sonora is enormous. With railroad transportation and the consequent cessation of Indian raids, this trade will necessarily become tributary to our line.

At Fort Yuma we connect with the steamboats on the Colo-

rado, which run about 450 miles up the river to Callville, which is within 100 miles of the Mormon town of St. George, and within 400 miles of Salt Lake City. We will also connect by steamer with the numerous towns and settlements both in Sonora and Lower California, on the Gulf of California.

San Gorgonio Pass is the connecting point of the Southern Pacific Railroad of California; the distance, San Gorgonio Pass to San Francisco, *via* Cajon Pass, is 459 miles; *via* San Bernardino, Los Angelos, San Fernando and Solidad Pass, 540 miles.

WATER SUPPLY.

From Shreveport and Texarkana to Fort Worth no material difficulty is encountered in obtaining water. Many of the streams run dry in the summer, but this difficulty can be overcome by the construction of artificial ponds at a slight expense. The same state of affairs exist from Marshall to Texarkana, varied by a more frequent supply of water from natural springs. From Fort Worth to the Rio Grande the large and constant streams we cross are the Clear Fork of the Trinity, Brazos and Pecos. From these, as well as their tributaries and sulphur springs, abundant supplies can be obtained at all seasons of the year. At other points on this division it will be necessary to construct ponds and dig or bore wells. About half-way across the Staked Plains water is found in abundance by digging a few feet below the surface, and the formation of the whole country west of Sulphur Springs, and particularly west of the Guadaloupe Mountains, is peculiarly favorable for obtaining water by sinking Artesian wells. On the Rio Grande, and up to La Messilla, we shall find abundant supplies of water from the river. After leaving the Rio Grande we shall have to depend on artificial ponds and wells until we reach Cook's Springs, 30 miles from the Rio Grande. These springs are 8 miles north of the line and afford an abundant supply of water, which can easily be brought to the line in pipes. Fifteen miles west of this water can be obtained in the valley of the Miembres at a depth of 20 or 30 feet. 20 miles west of the Miembres, and 12 miles north of the line, are the Ojo de Vacca Springs, from which a supply can be obtained by pipes. About 40 miles west of this, and opposite the Rallston Silver Mines, water can be obtained in sufficient quantities at a depth of 40 feet, and 40 miles west of this, water can be found at a rea-

sonable depth in the valley of San Simon. If this should fail, water can be brought in pipes from a running stream 6 miles south of the line up the valley. The first running water west of this is the San Pedro, a distance of 65 miles. 20 miles further west we reach the valley of Cunega, which is a running stream for 10 miles along the road. From this point west, to the Gila, we will have to depend on wells and ponds. In the valley of the Santa Cruz water can probably be had at depths varying from 15 to 20 feet. From the Pima Villages to Fort Yuma water will be obtained at little cost from the Gila and its tributaries. Through the New Mexico Division the lay of the strata is favorable to finding water at all points at a reasonable depth, and in one or two instances Artesian wells already sunk have afforded a large supply of water. From the Colorado to the Coahuila valley, a distance of 113 miles, there is no water on the surface, and it will be necessary to construct reservoirs or to sink Artesian wells; every indication exists that water can be procured by boring to a reasonable depth. In the Coahuila valley water is procured at a depth of 15 feet. Between this valley and the summit of San Gorgonio Pass, water in abundance can be procured within 2½ miles of the road, being brought to the line by pipes. From San Gorgonio Pass to San Diego no difficulty will be found in obtaining water. From the above it will be seen that at many points on the road provision will have to be made for water in advance of the construction of the road, and on these divisions this fact will materially increase the cost of construction.

This has been considered in making up the estimates submitted with this report. No difficulty has been encountered east of the Central Railroad, in Texas, in obtaining permanent supplies of water. We have used reservoirs in some cases. Abundant supplies of water can be obtained from living streams. There is an abundance of water for cattle on the whole line, and no difficulty is found by the settlers in obtaining water by digging wells to a depth not exceeding 30 feet.

TIMBER.

On the lines east of Fort Worth timber abounds on all the streams, and no difficulty has been found in obtaining timber for ties anywhere within a reasonable distance of the line. The

pineries extend from the east 100 miles on the Southern Division and 60 miles on the Trans-continental Division. Vast forests of oak also exist in the same districts. On the Jefferson Division we pass through and within reach of vast bodies of pine, oak and cypress timber. This portion of our line will furnish enough timber for all purposes for the whole country which the Texas and Pacific will develop for years to come, and will be a great source of traffic to the road.

The lumber is now manufactured at the mills at from $10 to $15 per thousand, and as the lumbering interests of eastern and south-eastern Texas are developed the facilities for manufacturing will keep pace with the demand, and will for a long time make lumber comparatively cheap.

In the valley of the Red River, from the east line of Texas to the mouth of the Big Wichita River, there is an abundance of fine oak, interspersed with extensive groves of red cedar, black walnut and bois d'arc.

For the first 150 miles west of Fort Worth, there is sufficient timber for cross ties, piling, trestle work, and fuel. 40 miles west of Fort Worth we pass through 12 miles of timber, known as the West Cross Timbers, a belt of timber extending across the whole State and parallel to the Cross Timbers east of Fort Worth, which will furnish a large number of ties for the divisions west. As we approach the Staked Plains, the timber gradually becomes scarcer until it disappears.

On the Pecos Division, on the Guadaloupe, Hueca and Organ Mountains, there are bodies of pine, cedar and spruce, sufficient to tie the western part of the road, but they are so located as to add greatly to their cost in transporting them to the road.

In estimating the cost of the road, we have provided for this material to come from east of Fort Worth. For construction, the supply of timber west of the Staked Plains and east of the Rio Grande has not been considered. They are, however, valuable in operating the road, and for their value we refer you to the valuable suggestions of Major Hurd in his report annexed.

The principal supply for the eastern portion of the New Mexico Division must be procured either from the rear or from the Tulerosa Pineries in the Sacramento Mountains, about 45 miles from the line of the road. From La Mesilla, where

a large number of ties and large amount of bridge timber can be procured, or from the Organ Mountains where a limited supply can be obtained, 20 miles from the line.

West of the Rio Grande, the first timber found is on Cook's Peak Range, about 35 miles north of the line. West of this, all of the mountain ranges north of the line have more or less timber suitable for railroad work. 30 miles north of the line, on the north slope of the Burro Mountains, is a fine body of timber, also in the Chiricahua Range, 30 miles north. About 30 miles south of the line on the Cochin Reservation is an extensive pinery.

On the Graham, Caliuro, Santa Catalina and Santa Rita Mountains are bodies of timber which would have to be hauled 30 or 40 miles.

From the Pima Villages to San Diego there is no timber on the line of the road, and timber for the construction and maintenance of the road must be procured either from the mountain ranges referred to, Eastern Texas, or the Pacific Coast.

In making our estimates from Fort Worth to the Pima Villages, with the first 200 miles, we have considered that all timber would be brought from Eastern Texas. From that point west we have considered all timber and material to come from San Diego. In this connection we would call your attention to the immense pineries in the Sacramento Mountains, now being used to supply New Mexico, and which, no doubt, by the time we enter New Mexico, will be brought within reach of our line by the Denver and Rio Grande Railway.

FUEL.

Timber.

From Shreveport to Fort Worth, on both lines, fuel can be obtained at low prices, and can, with few exceptions, be so placed on the line as not to require distribution to wooding stations by trains. Sufficient timber for fuel is found along the line of the road from Fort Worth to Sulphur Springs, also on the east side of the Staked Plains, also on the east slope of the Guadaloupe Mountains, and on the Rio Grande, within a reasonable distance of our line. West of the Rio Grande to Fort Yuma fuel will have to be brought from the rear or hauled 20 to 40 miles from the track. From Fort Yuma to

San Diego we shall probably have to use coal from the Pacific Coast.

Coal.

In crossing the Brazos Division the line passes through the centre of a coal field said to be 600 square miles in extent. Its croppings show in Parker County, Texas, "within 3 miles of our line, and 50 miles from Fort Worth," where a distinct vein of coal, 5 feet thick, crops out. To the north of this, in the north-west corner of Parker and south-east corner of Jack Counties, is a valuable vein of bituminous coal, 8 feet thick, which shows an out-crop of over 60 yards in length.

On the Clear Fork of the Brazos, in Palo Pinto County, and directly on the line of our road, and west of this, crossing from Shackelford into Stevens County, a vein shows plainly for 2 miles in length, and from 4 to 5 feet in thickness. Coal is also found in the north-west of Shackelford County, on the Clear Fork, near our line.

This coal field seems to outcrop over the western portion of Parker, Palo Pinto, Shackelford, Stevens and Young Counties, and over the southern part of Young, Throckmorton and Jack Counties, and will not only furnish a cheap supply of fuel for the use of the road, but will also give the road a profitable business in supplying the wants of the Prairie County east and west of the coal field.

The coal measure extends far north along the foot hills of the Rocky Mountains, and along the range as far south as the heads of the Red and Colorado Rivers, of Texas, and no doubt underlies the eastern portion of the New Mexico Division, and can be readily and cheaply mined when once determined and developed.

Evidences of this has been shown north of the Gila over a large extent of country, at Camp Apache in the White Mountain Range, near the boundary of New Mexico and Arizona, and also in the range north of Fort Stanton, at which post coal is used for fuel; also in the low range of Fra Cristobal, on the east side of the Rio Grande.

In the valley of the Rio Grande, near the Mexican boundary, a vein 6 feet in thickness of bituminous shale has been opened, and is now worked.

This coal is now used at Fort Bliss for blacksmith purposes,

and it will probably form an important source of supply for the road, and an important item of traffic.

BALLAST.

On the Trans-continental Division, from the north line of Denton County to Fort Worth, coarse, clear water-washed gravel is found in quantities directly on the line of the road, sufficient to supply the road west of Sherman to Fort Worth. From there to the Staked Plains stone and gravel for ballast will be found at intervals along the entire line. From the Pecos west no difficulty will be found in obtaining ballast from the natural soil for this Division

BUILDING STONE.

Building stone on the Southern Division, east of Fort Worth, is scarce ; a small quantity lies 4 or 5 miles from the line.

On the Trans-continental, limestone is found throughout Grayson County and sandstone throughout Denton County, both suitable, after they are reached by rail, to replace wood structures as they require renewal. On the banks of the Sulphur, in Fannin and Lamar Counties, a fine quality of white and magnesian limestone is found. This stone when newly quarried is easily worked with ordinary carpenter's tools, but on exposure to the air hardens very rapidly, is durable and retains its color well. It is not sufficiently strong for railroad work, but makes beautiful building material. Good stone for railroad purposes is to be had at intervals along the whole line west of Fort Worth. Wherever in the vicinity of the line so as to be available, it has been estimated in our structures. The road completed, it can be used to replace structures as they require renewal.

AGRICULTURAL RESOURCES.

The soil of that part of the country east of Fort Worth, heretofore described in the paragraph on Timber as Pine Land is a sandy loam, quite productive, especially in the river and creek bottoms. The uplands will produce 250 pounds of lint cotton, 30 bushels of corn, and 15 bushels of wheat to the acre. Vegetables are everywhere produced in great abundance, and the soil is peculiarly adapted to the

culture of grapes, peaches, apples and melons. West of the timber, except a strip about 8 miles wide, known as the "Cross Timbers," is what is known as "Black Land Prairie."

It is hardly possible to overstate the resources of this country for the support of a large agricultural and pastoral population. There is no other portion of the United States in a more healthful climate, or where the labors of the husbandman are so richly and surely rewarded. There is practically no waste land, the soil seems to be inexhaustible—under the worst possible system of cultivation, the ground is planted year after year with the same crops, and its fertility seems to remain unimpaired. The average yield of lint cotton on the black land is 500 pounds to the acre; corn, 50 bushels; wheat, 25; and rye, oats and barley from 40 to 60 bushels.

All fruits and vegetables grown in the Central, Southern and Western States flourish here. The Cross Timbers, above spoken of, extend from the south-east to the north-west through the State. The soil is a sandy loam, and produces equally as good crops of cotton and small grain as the Black Prairie, and judging from the success of experiments already made, will eventually become a great fruit and wine growing region.

When the country is thickly populated (and even now in consequence of our partial railroad facilities the population is rapidly increasing) there will be no agricultural country of equal extent on the continent that will furnish a larger freighting business.

The appearances and characteristics of the country first described, and those of the Black Prairie region, are as different as if these regions pertained to different continents. Between the yellowish loamy soil of the one, clothed with dense forests of pine, oak, etc., and the black, adhesive soil of the prairie regions, the contrast is very striking.

The country between Fort Worth and the Brazos River is considered by the settlers living in it to be the finest farming portion of Texas. It produces heavy crops of wheat, barley, oats, corn and cotton. 400 pounds of lint cotton is considered in this district as an average crop, and of corn 40 or 50 bushels to the acre, with a much larger production in the valleys.

The country west of the Brazos to the Salt Fork of the Colorado is fertile, particularly in the valleys, but at present,

owing to sparse population, stock raising is the principal occupation of the settlers. This country is covered with an abundance of natural grasses, the stock grazing throughout the year and keeping in good condition. The rainfall averages about 20 inches per annum, and very little snow, some years passing without any. The heaviest fall of snow for many years has not exceeded 4 inches.

On the "Staked Plains," so named from the fact that a road was marked across them by stakes, the gramma grass grows luxuriantly, the soil is rich, and the only thing wanting is a supply of water, which, it is confidently believed, can be procured in abundance by boring. Only this expenditure of money is necessary to make it the greatest cattle raising region of the West, and its capacity as a farming country is only limited by the supply of water.

The Pecos River furnishes a never failing supply of water for irrigation and all other purposes. Its valley is as rich as that of the Rio Grande, is wide, and would be rapidly settled if it were not for the hostile Indians.

West of this to the valley of the Rio Grande may be considered a grazing region, sufficiently well watered, with a large proportion of the land available for raising crops by irrigation.

The fertility of the valley of the Rio Grande when it is irrigated is extraordinary, producing corn, wheat, barley and cotton; no country on the continent is superior to it for fruit, especially for grapes. Large quantities of wine of excellent quality are made in the valley. The area of this valley is large enough, and with the water available from the Rio Grande for irrigation will support a dense population, and export a large amount of produce to the mining regions on both sides of it.

The plains, valleys, passes and mountain sides from the Rio Grande to the Santa Catalina range are well covered with nutritious grasses, and will afford food for all the stock that conveniently find water in the streams, springs and wells. The transportation of cattle from this district will form a large source of revenue to the road. The valleys of the San Pedro and Gila are exceedingly rich. In the valley of the Gila there are found evidences that it was once the home of a dense population; water of an excellent quality is found everywhere in this valley at a depth of less than 30 feet. The valley is from $1\frac{1}{2}$ to 5 miles wide, and all of it is capable of producing enormous

crops. This land with irrigation produces from 35 to 45 bushels of wheat and 50 to 60 bushels of barley to the acre.

West of the Pecos the cultivation of the country is limited by the supply of water, hence only the valleys have been used. The mountain sides and mesas are rich in soil and the growth of grasses, and with its climate make it one of the most successful stock-growing countries in the world. Vast herds of sheep and cattle are now raised on the mesas. The elevation of a great portion is between 2,500 and 4,000 feet above tide-water, high enough to be healthy, while the winters are mild and free from snow.

From the Rio Grande to Fort Yuma a daily meteorological report was kept, which shows only one fall of snow from July 4th, 1872, to May 28th, 1873, and this fall was only 2 inches, which disappeared entirely in two days.

The agricultural resources of Southern California are now as well-known as those of the New England States; it produces immense crops of wheat, which over the Texas and Pacific Railway will find a ready market in the mining regions East, and its semi-tropical fruits will give us no inconsiderable business over our whole line.

MINERAL RESOURCES.

The precious metals of West Texas, New Mexico, Arizona and Southern California are practicably inexhaustible, and but a very small portion of the country has been explored; developments have been retarded by the hostility of the Indian tribes, and chiefly for want of transportation. In spite of these drawbacks a considerable amount of silver and copper is shipped from the mining districts in New Mexico and Arizona. No attempt will be made in this report to give a general description of the mineral wealth of this country, and attention will be called only to such points as have been reported on by the geologists accompanying the Engineer Corps.

IRON.

In the Counties of Harrison, Marion, Cass and Titus, in the eastern part of Texas, large deposits of iron ore are found; this is now successfully worked near Jefferson, Texas, and before the war several other works were in operation. The iron produced is of very good quality, and the only reason it has not

been developed before this into a large source of wealth has been the want of a market and cheap fuel, and cheap means of transportation for the manufactured products. Large bodies of iron ore also exist in the Cross Timbers, but these have not been sufficiently developed to form an idea of their value. It is also found in large quantities on the headwaters of the Brazos River, to the north of our line of road, near Double Mountains; the outcrop shows that it covers a large extent of country. The proximity of fuel to this ore will undoubtedly render it valuable.

A large vein of brown hematite and micaceous ore was examined near Fort Bowen. The iron deposits of North-western Texas are of the most remarkable character, equaling in extent and richness those of Sweden, New Jersey, Missouri and New York. They include almost every variety, spaltish, magnetic, specular and hematite ores. The largest deposits of magnetic ores are situated in Mason, Llano and more western counties. Immense loose masses of ore lie scattered over the surface which have been upheaved by igneous agencies from unknown depths below. Most of these deposits are in true veins. As no true metallic vein has ever been traced downward to its termination, the supply is inexhaustible.

The analysis of an average specimen gave 90 and 96 per cent. of oxide of iron, with 2.818 per cent. of insoluble silicious substances, proving it to be magnetic oxide, which will yield 74.93 pounds of metallic iron to the 100 pounds of ore.

COPPER.

Copper is found generally distributed over the northern portions of Shackelford and Jones Counties, and over the Counties of Haskell, Throckmorton, Baylor and Wichita, Texas. In the Lone Mountain District, near Silver City, are rich and extensive leads, the Hanover and Santa Rita, which yield from 50 to 75 per cent. of copper. These leads have been worked at intervals for the last 100 years, and are among the largest copper deposits in the United States. A large vein of copper, 3 feet in thickness, was traced for some distance on the Gila, below the San Pedro. North of this, from the Spire and Pinal Ranges, quite a large amount of copper has been mined and marketed.

ARGENTIFEROUS COPPER.

A vein of silver-bearing copper is found 30 miles south of Florence, in the Spire Range, near the mouth of the San Pedro; it is 200 feet wide, and shows a depth exposed on the side of the mountain of 400 feet; the ore assays 65 per cent. of copper, with a strong trace of silver. The Gray copper mines near the Gila, abandoned in 1861 on account of Indian depredations, were worked profitably and yielded 80 per cent. of copper, with a strong trace of silver. The Silver Queen mine, 10 miles north-east of Florence, is worked by a company of capitalists; the entire opening is 21 feet wide, of argentiferous copper, and plainly traceable on the surface for 3,000 feet; at 20 feet depth it assays 50 per cent. copper and $260 per ton silver. The ore is a sulphuret; it has been shipped to San Francisco and sold to the Swansea Company at $200 per ton. Old mines supposed to have been formerly worked by the Jesuit Fathers have lately been reopened in the Tuttle District, 45 miles west of Tucson, as follows: the Elgin Mine, an old inclined shaft 953 feet deep, vein 14 inches wide at the top and 9 feet 8 inches wide at the bottom; the analysis of an average specimen gave 65 per cent. copper and $450 silver to the ton. The Hidden Treasure, 800 feet from the Elgin—the old shaft penetrates the mountain 1,200 feet, vein is 4 feet 6 inches wide, ore assays 65 per cent. copper, quantity of silver to the ton not stated. The Papago Chief is 900 feet south of the Elgin in an open cut, average depth 45 feet, vein 5 feet 6 inches wide; it contains some virgin copper and assays $395 silver to the ton. The Banco Mine is on the east side of the San Pedro, above the mouth of the Barbacorona, an outlying peak of the Dragoon Range; the vein is 20 inches thick, and the shaft 40 feet deep; the vein is traceable on the surface for several thousand feet.

SILVER.

In the Hueco Range, in our reservation, silver has been found, value unknown to us, except that responsible parties have made application to lease, which leads us to suppose that the lead is valuable.

At the head of the cañon of the Gila is a thin vein of black sulphuret of silver. In the Santa Cruz Mountains, 18 miles south of Tucson, rich veins of silver have been opened. At

Cienega Station, at the head of Cienega River, is a very rich and large vein of silver. The Titus New York Company had a mill 10 miles west of Fort Buchanan; the ores worked came from the Padre Santo and Lost Mountains, and yielded from $70 to $100 per ton. The Ralston Silver Mines, on the line of the road, have inexhaustible quantities of a low grade of silver ore, which will well repay the owners when they can obtain transportation for fuel. The Pinos Allos veins, near Central City, produce both gold and silver; a shaft has been sunk 150 feet, vein from 3 to 8 feet wide, and a drift has been carried 1,100 feet in the vein—$184,000 of bullion has been obtained from the vein. The Lone Mountain Mines are situated near Central and Silver City, and about 10 miles west of Fort Bayard.

The following named leads are now worked: Humbug Lead, with its associate veins, cover a breadth of from 100 to 500 feet, and can be traced for over a mile; ore assays $100 to the ton, actual product $75 per ton. Durango Lead, south-east of this, can be traced on the surface for about 3,000 feet; a shaft has been sunk on this lead 62 feet deep; the vein is vertical and from 2 to 4 feet wide—ore assays $200 silver per ton. This vein is crossed by another equally rich, on which is located the Sunlight Shaft.

Mr. Knapp, Geologist of the New Mexico Division, says of the Lone Mountain District:

"The country rock is hard limestone, and the ore is associated with quartz and selenite; the veins run in heavy leads north and south, but at many places the intervening rock is so filled with veins crossing and recrossing that the limestones are boulders rather than ledges."

The ore yields $100, practically $60 silver, per ton. Mr. Knapp estimates the amount of ore of this richness in the district at 4,000,000 tons. When the railroad is completed, it will be more profitable to transport this ore to points where cheap fuel and water are more abundant than in the vicinity of the mines.

ARGENTIFEROUS LEAD.

This has been discovered in large quantities near "Pyramid Peak," at the "Ralston Silver Mines;" this ore covers a wide tract of country, extending from the Gila to the summit of the divide between the Gila and Salt River.

LEAD

has been found in places on Grindstone Creek, in Parker County.

GOLD.

A vein of gold-bearing quartz, 2 feet wide and extending to the top of the mountain, 2,000 feet high, was found and examined at the head of Gila Cañon. Placer gold diggings were formerly worked at the point of the Burro Mountains.

Indications of gold also exist in the Lone Mountain District, and gold has been dug out and marketed from the Pemos Allos Mines, in this district. Good specimens of gold-bearing quartz were found on the banks of Mineral Creek, and it is believed that good placer diggings will be found on the headwaters of this creek. This creek runs along the foot of the Spiral Range, and separates it from the Pimal Range.

The gold and silver mines south of the line in California are extensive in the foothills and main range of the Sierra Nevada Mountains. Many of the districts are extensively worked, but are limited by the cost of transportation of ore and bullion. Mineral developments have been retarded by Indian incursions and the want of water and transportation. The construction of this road will obviate the first entirely, and will make an opportunity for industry to overcome the other.

ORE MILLS.

A large business is carried on at Central City, Silver City and Lone Mountain Mines, reducing the ores of the Lone Mountain District. There are two mills at Silver City, one at Central City and one at Lone Mountain. These mills do not work any ore that averages less than $100 per ton, of which they save about one-half.

Other works have been operated on the line, but have been abandoned on account of frequent attacks by the Indians.

The precious metals of Eastern Texas, New Mexico, Arizona and Southern California are inexhaustible, and but a very small portion of the country has been explored.

All that is required to make this the richest mining country in the world, is the cheap transportation that would be afforded by the construction of a railroad, and the pacification of the

Indians, which would be the necessary result of such construction.

SALT.

Salt is found at many points on the line. There are a great many salt lakes and springs in Texas. Salt is manufactured in the great laboratory of the nation by solar evaporation. The most important locality, producing almost an inexhaustible quantity, is west of Horsehead Crossing, on the Pecos River, west of the Guadaloupe. The salt here is ready formed and needs only to be shoveled up and taken to market. The water is so strongly impregnated that the human body cannot be made to sink in it. The salt is very pure, and fit for table use without refining. At the salt lake between the Gaudaloupe and Hueca Ranges is found large deposits evaporated by the sun, from which the State of Chihuahua and Northern Mexico draws its supply. Also in the Colorado Desert of California there is a salt laguna which covers about 50 square miles, where salt of remarkable purity and color is found in blocks 6 to 15 inches thick.

GYPSUM.

In the northern portion of Texas is the largest deposit of gypsum known to exist in the world, spreading over 200 miles on the Upper Red River and its tributaries. Some of the specimens are as transparent as the purest glass, and easily split into thin layers. The line crosses this deposit for a considerable distance west of the Brazos.

ESTIMATES.

In estimating the cost of the work, I have divided it into two divisions.

1st. East of Fort Worth, which is estimated by divisions.

2d. West of Fort Worth, which is estimated by the hundred miles.

It will be seen that the estimates for transportation are very large. This is so from the fact that I estimated that all crossties and bridge timber used in construction between Fort Worth and the Pima Villages in Arizona would be transported from some point east of Fort Worth.

Transportation is also estimated over our own road at 2½

cents per ton per mile, which is just about double the actual cost. If estimated at actual cost, it would reduce the cost of transportation $2,000 per mile. And should we be able to obtain our cross-ties along the line (which I am confident can be done on a large portion of it) it will reduce the cost of ties about $500 per mile.

The estimated quantities are large, and full prices have been allowed. Earth from 26 to 35 cents, and classified excavation $1.50 per cubic yard.

The estimates show for 1,915 miles of road a total cost of about $60,000,000 dollars, probably by far the cheapest of any line now built or contemplated, if its estimates are made on the same basis as these.

The tables of estimates are so arranged that they can be criticised as a whole or in their details.

I have based these estimates upon my experience in building a similar road, and the two years' experience I have had in building this road, also from a personal knowledge of the country through which this line runs and its resources, and have no hesitancy in saying that a road, first-class in all its parts, fully up to the requirements of the government, and a large part of its structures permanent, with sufficient rolling stock, and probably better appointments for water, buildings and shops than any road of the same length west of the Ohio River and Lakes, can be built for the estimates submitted.

The cost of construction will compare favorably with any other trans-continental line built or projected. Ample preparation has been made for everything except discount on bonds and payment of interest during construction.

The tables have been compiled from preliminary surveys, and, on location, will be improved, especially in grades and distance. They are as follows:

1. Road in operation.
2. Table of elevations and summits.
3. " " distances.
4. " " quantities in construction.
5. " " cost of construction.
6. " " grades.
7. " " rolling stock.
8. " " comparison.

ROAD IN OPERATION.

The line from *Shreveport* to *Dallas*, 186 *miles*, is completed, and regular trains have been running since July 1st.

From *Marshall* to *Texarkana*, 74 *miles*, is also completed, and regular trains have been running since January 1st, 1874.

From *Sherman* to Brookston, 56 *miles*, is also completed, and regular trains are now running.

In all, we have 316 *miles* in *operation*.

OTHER CONSTRUCTION,

IN ADDITION TO THE ROAD COMPLETED.

From *San Diego, East*, 10 *miles*, are graded, bridged, and ties delivered ready for the iron.

The *Trans-Continental Division*, from *Brookston* to the *Jefferson Division*, *Texarkana*, 87 *miles*, is also graded, bridged, and ties delivered.

From *Sherman, West*, 7 *miles* are graded, and ties delivered for the same.

In *Denton County* 4 *miles* are graded.

From *Dallas West*, 3 *miles* are *graded* and *bridged*, and *ties* have been got out for the whole distance from *Dallas* to *Fort Worth*.

RECAPITULATION.

316 miles road in operation.
104 " graded, bridged and tied, ready for iron.
3 " graded, partly bridged, and ties delivered.
4 " graded.

GENERAL ELEVATION (ABOVE THE SEA) FROM RED RIVER TO SAN DIEGO, ON THE LINE OF THE TEXAS & PACIFIC RAILWAY:

	Feet Above tide water.
Shreveport,	204
Marshall,	377
Jefferson (Jefferson Branch),	226
Texarkana (Trans-Continental Branch),	287
Longview,	342
Silver Lake,	350
Divide, between Sabine & Trinity Rivers,	529

	Feet Above tide water.
Dallas,	481
Sherman (Trans-Continental Branch),	734
Fort Worth,	629
Weatherford,	1,000
Divide, between Trinity and Brazos Rivers,	1,195
Valley of the Brazos,	825
Staked Plains,	2,850
Highest point on same,	3,377
Valley of the Pecos,	2,700
Hurd's Pass (Guadaloupe Mts.),	4,493
Valley West of Guadaloupe,	3,640
Hueca Pass,	5,027
El Paso (or Fort Bliss),	3,732
Table Land (Sierra Madro),	4,420 to 4,520
Summit of Continent,	4,893
Peloncello Pass,	4,339
San Simon Valley,	3,562
Rail Road Pass,	4,388
Nugent's Pass,	4,711
San Pedro River,	3,429
Cunega Station,	4,088
Tucson,	1,898
Pima Villages,	1,193
Fort Yuma,	145
Divide, between Gila and Colorado Desert,	437
Salt Lake (Dry), in Colorado Desert—below tide water,	290
Cabazon Valley,	998
San Gorgonio Pass,	2,621
Santa Marguerita Ranches,	104
San Diego (on the Pacific),	16
Tres Alamos,	3,729

TABLE OF SUMMITS.

	ASCENDING.											DESCENDING.														
	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	Level.	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 105	Ascent.	Descent.	Total Ascent.	Total Descent.	Loss of Grade.	Miles.
Ascending from Pecos to Hurd's Pass	.39	13.35	15.15	7.64	3.22	3.69	2.08	1.89	.95	1.32	....	0.57	1.14	....	....	....	....	....	....	....	....	19.80	.35	19.45	.....	.35	53.34
Descending from Hurd's Pass to Salt Lake Valley	1.22	.38	.....	.28	.....	.....	.....	.....	.....	.....	1.89	1.60	4.26	2.84	....	2.69	2.56	1.14	0.18	1.14	.76	25.00	910.	.....	885.	25.	21.02
Ascending to Hueco Pass	2.46	.....	9.06	2.65	1.53	2.55	.85	...	.69	1.28	.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	829.62	.....	829.62	.....	.....	21.33
Descending from Hueco Pass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.30	....	1.60	.38	.85	...	5.39	1.65	3.22	3.54	....	.....	.....	990.	.....	.....	17.93
Ascending from Rio Grande to Sierra	.45	.95	....	1 33	2.08	3.50	....	.....	.....	.....	.19	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	401.	.....	401.	.....	.....	8.59
Ascending to Peloncello Summit	.....	.....	.....	0.38	0 67	....	0.76	0.34	0.28	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	191.	.....	191.	.....	.....	2.53
Descending Peloncello to San Simom Valley	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.88	.47	.85	....	.95	2.45	4.55	0.58	4.07	.....	.....	.....	777.	.....	777.	....	14.80
Ascending to Nugent's Pass	0.62	1.42	0.34	....	4.55	1.55	...	0.66	.....	.....	1.60	....	.27	.....	.....	.....	.....	.....	.....	.....	....	512.	5.	507.	.....	5.	10.99
Descending from Nugent's Pass to San Pedro	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.57	....	38	.32	3.27	.20	5.14	7.94	2.34	....	.....	.....	.....	1280.	....	38.18
Ascending from San Pedro to Cunega Summit	.64	.76	2.29	.19	1.33	2.50	....	4.72	.....	.....	.22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	659.4	.....	.....	23.95

TABLE OF DISTANCES BY TEXAS AND PACIFIC RAILWAY.

FROM	TO	San Diego.	San Francisco.	Galveston.	New Orleans.	Vicksburg.	St. Louis.	Chicago.	Memphis.	Atlanta.	Chattanooga.	Nashville.	Louisville.	Cincinnati.	New York.	Philadelphia.	Baltimore.	Charleston.	Savannah.	Brunswick.	Washington.
San Francisco		.....	.....	2,115	2,515	2,214	2,547	2,818	2,336	2,783	2,645	2,567	2,713	2,823	3,473	3,363	3,324	2,967	2,864	2,796	3,251
San Diego		.....	.....	1,803	2,153	1,852	2,182	2,453	1,973	2,420	2,282	2,204	2,350	2,460	3,110	3,059	2,961	2,604	2,501	2,432	2,886
Los Angelos		.....	.....	1,773	2,123	1,822	2,125	2,426	1,944	2,391	2,253	2,175	2,321	2,431	3,081	3,030	2,932	2,575	2,472	2,403	2,857
San Bernardino or Gorgonia Pass.		87	450	1,716	2,065	1,764	2,097	2,368	1,886	2,333	2,195	2,117	2,263	2,373	3,023	2,972	2,874	2,517	2,414	2,345	2,799
Fort Yuma		270	733	1,532	1,882	1,581	1,914	2,285	1,703	2,150	2,012	1,934	2,080	2,190	2,840	2,789	2,691	2,334	2,231	2,162	2,616
Pimos Villages		445	808	1,357	1,707	1,406	1,739	2,110	1,528	1,975	1,837	1,759	1,905	2,015	2,665	2,614	2,516	2,159	2,056	1,987	2,441
Tuscon		529	892	1,273	1,623	1,322	1,655	2,026	1,444	1,891	1,753	1,675	1,821	1,931	2,581	2,530	2,432	2,075	1,972	1,903	2,357
Tres Alamos		592	955	1.214	1,564	1,263	1,585	1,866	1,384	1,832	1,704	1,616	1,790	1,771	2,546	2,356	2,358	2,016	1,913	1,845	2,298
Ralston		695	1,058	1.107	1,457	1,156	1,478	1,759	1,277	1,725	1,587	1,509	1,683	1,664	2,439	2,249	2,251	1,909	1,806	1,738	2,191
Silver City		722	1,085	1,080	1,430	1,129	1,451	1,732	1,250	1,698	1,560	1,482	1,656	1,637	2,412	2,222	2 224	1,882	1,779	1,711	2,164
Mimbres		746	1,109	1,056	1,406	1,105	1,427	1,708	1,226	1,674	1,536	1,458	1,632	1,613	2,388	2,198	2,200	1,858	1,755	1,687	2,140
La Mesilla		813	1,176	989	1,339	1,038	1,360	1,641	1,159	1,607	1,469	1,391	1,565	1,546	2,321	2,131	2,133	1,791	1,688	1,620	2,113
Fort Bliss or El Paso		843	1.206	958	1,308	1,007	1,329	1,610	1,128	1,576	1.438	1,360	1,505	1,515	2,290	2,100	2,102	1,760	1,657	1,589	2,082
Pecos River		1,036	1,399	765	1.115	814	1,136	1,417	935	1,383	1,245	1,167	1,312	1,322	2,097	2,007	1,909	1,567	1,464	1,396	1,889
Sulphur Springs		1,164	1,527	638	988	687	1,019	1,220	808	1,256	1,118	1,040	1,185	1,195	1,970	1,880	1,782	1,440	1,337	1,269	1,762
Double Mt		1,248	1,611	553	903	602	924	1,205	723	1,171	1,033	955	1,100	1,110	1,885	1,795	1,697	1,355	1,252	1,184	1,677
Fort Griffin		1,332	1,695	469	819	518	840	1,121	639	1,087	949	871	1,016	1,026	1,801	1,711	1,613	1,271	1,168	1,100	1,593
Weatherford		1,423	1,786	378	728	427	759	1,030	548	996	858	780	925	935	1,710	1,620	1,522	1,180	1,077	1,009	1,502
Fort Worth		1,457½	1,820½	344	694	393	725	996	514	962	824	746	891	901	1,676	1,586	1,488	1,146	1,043	975	1,468
Denton		1,486	1,849	412	762	481	698	969	487	935	797	719	864	874	1,649	1,559	1,461	1,119	1,016	948	1,431
Sherman		1,538	1,901	379	729	448	645	916	434	882	744	676	811	821	1 596	1,506	1,408	1,066	963	895	1,387
Bonham		1,565	1,928	406	756	417	618	889	407	855	717	649	784	794	1,569	1,479	1,381	1,039	936	868	1,357
Honey Grove		1,581	1,944	432	772	399	600	871	389	837	699	631	766	776	1,551	1,461	1,363	1,021	918	850	1,339
Paris		1,602	1,965	443	793	383	580	851	369	817	679	601	746	756	1,531	1,441	1,343	985	882	814	1,323
Clarksville		1,632	1.995	439	789	348	545	816	334	782	644	566	711	721	1,496	1,406	1,308	950	847	779	1,288
Texarkana		1,693	2,056	383	733	292	489	760	278	726	588	510	655	665	1,440	1,350	1,252	894	791	723	1,232
Jefferson		1,650	2,013	324	674	233	548	819	337	785	647	570	766	724	1,499	1,409	1,311	954	851	783	1,173
Dallas		1,488	1,851	315	665	363	710	981	499	942	809	731	876	886	1,665	1,571	1,473	1,116	1,013	945	1,438
Mineola		1,535	1,898	291	641	287	633	904	421	870	732	655	851	809	1,584	1,494	1,396	1,039	936	868	1,361
Longview or International Junc.		1,621	1,984	285	635	240	587	858	375	824	686	609	805	763	1,538	1,448	1,350	993	890	822	1,315
Marshall		1,634	1,997	308	658	217	564	835	353	801	663	586	782	740	1,515	1,425	1,327	970	867	799	1,292
Shreveport		1,674	2,037	348	698	177	604	875	393	841	703	626	768	780	1,555	1,465	1,367	1,010	907	839	1,252

Short Water Lines via Texas and Pacific Railway, and contemplated connections: San Diego to Indianola, Texas, 1,460 miles; San Diego to Galveston, Texas, 1,480 miles; San Diego to New Orleans, La., 1,830 miles.

Distances by Texas and Pacific Railway, and Atlantic and Pacific Railway via Double Mountain Junction (450 miles West of Shreveport), and Vinita Terminus of A. & P.: New York to San Diego, 3,057 miles; New York to Los Angelos, 3,031 miles; New York to San Francisco, Coast Line, 3,451 miles; New York to San Francisco by Southern Pacific of California, 3,516 miles.

ESTIMATED QUANITIES, TEXAS & PACIFIC RAILWAY.

FORT WORTH to SAN DIEGO. Miles.	Clearing. Acres.	Grubbing Stations.	Earth Excavation. C. Yds.	Classified Excavation. C. Yds.	Bridge Timber. ft. B. M.	Piling. Lin. ft.	Cross Ties. No.	Iron and Spikes. lbs.	Howe Truss Bridges. Lin. ft.	Masonry. C. Y. 1st C	Masonry. C. Y. 2d C.	Masonry. C. Y. 3d C.	Tunnelling. C.yds.	Draw Bdge. Lin ft.
1 to 100 Incl.	60	70	2,122,000	209,630	2,170,000	43,000	277,200	54,200	1,430	.....	.....	.....	.....	.....
101 to 200	60	70	1,339,642	100,000	1,490,000	30,000	277,200	37,839	400	.....	4,000	.....	.....	.....
201 to 300	30	62	1,874,654	340,000	2,330,000	5,000	277,200	53,390	250	.....	.....	1,400	.....	.....
301 to 400	60	70	1,273,401	96,000	62,000	.....	277,200	143	.....	.....	.....	.....	.....	.....
401 to 500	60	70	905,657	91,000	67,000	600	277.200	152	125	.....	.....	2,000	.....	.....
501 to 600	60	70	1,473,758	230,000	75,000	.....	277,200	.....	.....	.....	.....	600	.....	.....
601 to 700	50	53	680,608	7,000	87,000	2,000	277,200	.....	.....	.....	.....	2,500	.....	.....
701 to 800	40	42	933,600	59,000	46,000	2,000	277,200	.....	550	1,500	.....	5,000	.....	.....
801 to 900	40	71	957,741	10,000	68,000	.....	277,200	.....	50	1,800	.....	8,000	.....	.....
901 to 1000	90	82	541,772	.....	35,000	.....	277,200	.....	.....	.....	.....	3,000	.....	.....
1001 to 1100	.....	.....	625,789	52,000	346,000	7,872	277,200	.....	.....	.....	.....	900	.....	.....
1101 to 1187.30	.....	.....	504,000	43,900	284,000	12,300	241,700	.....	750	2,000	.....	675	.....	300
1187.30 to 1350.58	.....	.....	880,598	72,000	670,000	53,600	451,800	30,655	.....	1,320	.....	4,800	.....	.....
1350.58 to 1390.58	.....	.....	839,381	287,907	1,200,000	.....	110,880	42,283	350	2,724	2,574	.....	6,498	.....
1390.58 to 1457.64	.....	.....	1,812,195	165,689	2,356,908	77,714	185,714	121,000	2,250	2.900	2,932	15,000	8,122	.....
1457.64 miles. Total.	550	660	16,764,796	1,764,126	11,286,908	234,086	4,039,294	339,662	6,155	12,244	9,506	43,875	14,620	300
Longview 153 miles to Fort Worth.....	1,587	2,340	2,854,000	10,643	2,952,683	162,172	424,324	84,546	1,220	.....	.....	.....	.....	.....
Marshall 69 miles to Texarkana Junction.	423	526	832,482	41,450	1,760,628	71,804	182,144	44,989	.....	.....	.....	.....	.....	.....
Texarkana 236 miles to Fort Worth.....	1,319	1,652	2,468,043	83,000	4,433,780	254,808	624,278	163,298	825	.....	.....	.....	.....	.....
Total.... 458 miles.	3,329	4,518	6,154,525	135,093	9,147,091	488,784	1,230,746	292,833	2,045	.....	.....	.....	.....	.....
Total....1915.64 miles.	3,879	5,178	22,919,321	1,899,219	20,433,999	722,870	5,270 040	631,495	8,200	12,444	9,506	43,875	14,620	300

West of Fort Worth.	Miles.	Clearing and Grubbing.	Earth Excavation.	Classified Excavation.	Bridging.	Tracklaying and Ties.	Buildings.	Shops.	Water Supply.	Telegraph.	Engin'r'g and Contingences.	Transportation.	Total Cost.	Total Average Per Mile.
1 to 100	100	$2,300	$556,100	$317,071	$160,752	$227,447	$30,000	$50,000	$35,000	$15,000	$200,367	$93,724	$1,697,761	$16,977.61
101 to 200	100	2,300	356,505	155,000	103,983	241,350	30,000	50,000	35,000	15,000	158,913	284,287	1,432,238	14,323.38
201 to 300	100	1,520	530,529	539,580	109,800	245,956	30,000	50,000	35,000	15,000	215,700	338,325	2,111,404	21,114.04
301 to 400	100	2,300	377,919	160,904	2,170	243,600	30,000	50,000	45,000	15,000	152,700	427,887	1,507,480	15,074.80
401 to 500	100	2,300	382,168	151,151	10,162	243,600	30,000	50,000	45,000	15,000	153,000	516,137	1,598,518	15,985.18
501 to 600	100	2,300	464,496	390,540	3,365	243,600	30,000	50,000	35,000	15,000	183,400	594,109	2,011,810	20,118.10
601 to 700	100	2,030	229,391	12,145	19,145	243,600	30,000	50,000	35,000	15,000	123,600	677,775	1,437,686	14,376.86
701 to 800	100	1,620	318,420	104,548	61,610	243,600	30,000	50,000	50,000	15,000	147,400	779,860	1,802,053	18,020.58
801 to 900	100	1,710	335,843	18,090	69,880	243,600	30,000	50,000	50,000	15,000	141,400	848,390	1,803,913	18,039.13
901 to 1000	100	3,520	201,911	.....	19,225	243,600	30,000	50,000	50,000	15,000	121,300	921,250	1,655,806	16,558.06
1001 to 1100	100	.....	200,250	106,000	23,114	243,600	30,000	50,000	30,000	15,000	129,600	342,490	1,170,054	11,700.54
1101 to 1187.3	87.30	.....	169,335	73,100	99,215	212,657	26,190	43,650	26,190	13,095	118,882	287,221	1,069,425	10,694.25
1187.3 to 1350.58	163.28	.....	279,179	93,000	98,835	397,730	48,984	81,640	48,984	24,492	205,000	265,453	1,543,297	9,451.83
1350.58to 1390.58	40	.....	257,814	496,841	150,210	97,440	12,000	20,000	14,000	6,000	129,400	35,324	1,219,029	30,478.00
1390.58to 1457.64	67.06	.....	543,658	412,598	396,396	163,106	20,124	33,540	20,124	10,062	200,200	27,854	1,827,662	27,246.00
Total 1457.64 miles	....	$21,900	$5,213,518	$3,030,568	$1,327,862	$3,534,486	$437,298	$728,830	$554,298	$218,649	$2,380,862	$6,440,086	$23,888,241	$16,386.82
Cost per Mile, 1457.64		$15.02	$3,576.57	$2,078.73	$909.70	$2,424.80	$300.00	$500.00	$380.21	$150.00	$1,633.65	$4,418.10	.....	.....
Shreveport to Longview	66	Constructed previous to 1872. Not estimated.												
Longviewto Fort Worth.....	153	85,557	1,019,959	88,984	315,409	328,356	87,711	256,704	36,498	30,600	327,160	47,576	2,624,514	17,153.68
Marshall to Texarkana	69	27,669	220,310	68,524	121,854	139,656	26,634	5,727	15,525	13,800	132,825	19,665	792,189	11,481
Texarkana to Fort Worth...	236	48,379	624,452	70,335	501,538	512,604	110,523	26,170	57,964	47,200	432,941	116,820	2,548,906	11,224.17
Total.....	524	$161,605	1,864,721	227,843	938,801	980,616	224,868	288,601	109,987	91,600	892,926	184,061	5,965,609	13,025.34
Cost per Mile.....		$352.84	$4,071.44	$497.35	$2,049.78	$2,141.10	$490.97	$630.11	$240.10	$200	$1,949.62	$401.88	.....	.....
Grand Total....	1915.64	$183,505	$7,078,239	$3,258,411	$2,266,663	$4,515,102	$662,166	$1,017,431	$664,285	$310,249	$3,273,788	$6,624,147	$29,853,850	$15,584.27

(Continued on next page.)

LONGVIEW TO SAN DIEGO. MARSHALL TO TEXARKANA JUNCTION. TEXARKANA TO FORT WORTH.

WEST OF FORT WORTH.	Machinery.	Rolling Stock.	Iron, Spikes and Fastenings.	Real Estate and Right of Way.	General and Legal Expenses.	Charter Privileges.	Total Cost.	Average Cost Per Mile.
1 to 100 Incl.	$5,000	$450,000	$997,500	$5,000	$25,000	$2,500	$3,182,761.00	$31,827.61
101 to 200	5,000	450,000	997,500	5,000	25,000	2,500	2,897,338	28,973.38
201 to 300	5,000	450,000	997,500	5,000	25,000	2,500	3,596,404	35,964.04
301 to 400	5,000	450,000	997,500	5,000	25,000	2,500	2,992,480	29,924.80
401 to 500	5,000	450,000	997,500	5,000	25,000	2,500	3,083,518	30,835.18
501 to 600	5,000	450,000	997,500	5,000	25,000	2,500	3,496,810	34,968.10
601 to 700	5,000	450,000	997,500	5,000	25,000	2,500	2,922,686	29,226.86
701 to 800	5,000	450,000	907,500	5,000	25,000	2,500	3,287,058	32,870.58
801 to 900	5,000	450,000	997,500	5,000	25,000	2,500	3,288,913	32,889.13
901 to 1000	5,000	450,000	997,500	5,000	25,000	2,500	3,140,806	31,408.06
1001 to 1100	5,000	450,000	997,500	5,000	25,000	2,500	2,655,054	26,550.54
1101 to 1187.30	4,365	392,850	870,817	4,365	21,825	2,183	2,365,840	27,088.23
1187.30 to 1350.58	8,164	734,760	1,628,718	8,164	40,820	4,082	3,968,005	24,301.84
1350.58 to 1390.58	2,000	180,000	398,000	2,000	10,000	1,000	1,812,029	45,300.74
1390.58 to 1457.64	3,354	301,860	669,123	3,354	16,720	1,677	2,823,750	42,095.26
1457.64 miles.....	$72,883	$6,559,470	$14,539,158.00	$72,883	$364,365	$36,442.00	$47,513,442	$31,236.82
Cost per mile.....	$50	$4,500	$9,975	$50	$250	$25	.....	.....
Longview 153 miles to Fort Worth.....	30,600	712,000	1,377,000	30,600	38,250	15,300	4,828,264	$31,557.21
Marshall 69 miles to Texarkana Junction.....	13,800	276,000	621,000	13,800	17,250	6,900	1,740,939	24,941
Texarkana 236 miles to Fort Worth.....	47,200	944,000	2,124,000	47,200	59,000	23,600	5,793,926	24,550
Total.....450 miles.	$91,600	$1,932,000	$4,122,000	$91,600	$114,500	$45,800	$12,363,129	$26,993.73
Cost per mile.....	$200	$4,000	$9,000.00	$200	$250.00	$100	.....	.....
Total.....1915.64 miles.	$164,483.00	$8,491,470	$18,661,158	$164,483	$478,865	$82,242	$59,876,571.00	.....

TABLE OF GRADES.

WEST OF FORT WORTH.	Miles.	MILES ASCENDING WEST. GRADE PER MILE IN FEET. 0 to 20	20 to 40	40 to 60	60 to 66	66 to 80	80 to 100	100 to 105	Level.
Grade 1 to 100	100	3.56	15.36	13.79	9.80	.....	.....	.....	26.28
" 100 " 200	100	16.51	13.48	10.38	12.99	.....	.....	.....	25.40
" 200 " 300	100	11.27	15.92	10.54	10.15	3.22	1.14	.....	16.09
" 300 " 400	100	24.15	11.87	6.08	.38	.38	.....	.....	12.76
" 400 " 500	100	18.19	26.57	9.39	1.34	1.34	3.46	.....	9.51
" 500 " 600	100	6.73	22.45	10.20	5.02	.....	2.18	.....	17.05
" 600 " 700	100	28.92	15.58	5.65	5.40	.....	.61	.....	16.06
" 700 " 800	100	20.16	10.76	7.18	.....	.....	.....	.....	15 36
" 800 " 900	100	6.83	10.07	17.78	2.53	5.55	.....	.....	7.82
" 900 " 1000	100	3.32	.72	.38	.....	.38	.....	.....	8.17
" 1000 " 1100	100	11.27	9.02	3.13	.....	.....	.....	.....	17.25
" 1100 " 1187.29	87.29	4.42	1.36	2.20	.....	.....	.....	.....	27.01
" 1187.29 to 1457.64	270.34	63.26	32.27	10.20	.....	7.73	3.96	9.83	41.02
Total West of Fort Worth	1457.64	.....	.....	.....	.....	.....	.....	.....	.....
East of Fort Worth....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shreveport to State Line	19.37	1.12	2.29	4.34	0.28	0.27	.....	.....	4.62
State Line to Longview.	44.19	1.48	3.26	5.32	2.35	4.22	0.82	.....	8.86
Longview to Dallas....	124.50	6.64	12.97	12.92	18.23	0.50	.....	.....	27.34
Dallas to Fort Worth..	30.81	0.95	3.27	2.73	5.77	.....	.....	.....	9.12
Marshall to Junction...	69.04	4.60	4.33	5.13	1.80	13.44	.....	.....	10.47
Texarkana to Paris.....	90.98	12.11	8.99	11.04	12.48	.....	.....	.....	12.02
Paris to Fort Worth....	145.13	8.21	11.36	10.69	27.38	.....	.....	.....	28.11
Total East of Fort Worth.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total Line.....	1981.64	253.60	231.90	159.07	115.90	37.03	12.17	9.83	340.32

(Continued on next page.)

TEXAS AND PACIFIC RAILWAY.

MILES DESCENDING WEST. GRADE PER MILE IN FEET.							Ascent. Feet.	Descent. Feet.	MAXIMUM GRADE.		LONGEST MAXIMUM GRADE STATIONS.	
0 to 20	20 to 40	40 to 60	60 to 66	66 to 80	80 to 100	100 to 105			Ascending.	Descending.	Ascending.	Descending.
4.18	8.25	15.63	3.17	....	.....	.....	1715.94	1286.00	66.00	66.00	39	40
.80	6.55	3.36	10.53	.....	.....	.....	1901.52	1467.90	66.00	66.00	151	130
11.25	7.14	7.78	5.50	.....	.....	.....	2161.35	1351.18	79.00	66.00	14	88
25.49	14.13	2.19	1.62	.95	.....	.....	947.18	1065.24	80.00	80.00	20	50
7.21	10.66	8.53	1.14	.95	.95	.76	2126.80	1091.00	96.00	110.00	70	40
8.05	12.51	4.98	1.68	4.22	4.81	.....	1634.57	1655.50	95.00	95.00	78	80
12.88	12.78	1.41	.18	.53	.....	.....	1386.18	483.95	79.00	79.00	32	11
13.91	11.44	15.84	1.26	4.09	.....	.....	870.76	1586.86	60.00	80.00	30	56
5.43	9.29	17.07	12.26	5.37	.....	.....	2005.77	2531.06	80.00	80.00	24	69
54.67	17.85	11.93	2.21	.36	.....	.....	384.66	1957.22	80.00	80.00	20	130
36.82	3.92	15.28	2.22	1.14	.....	.....	531.00	1371.96	52.80	80.00	25	60
46.49	3.96	1.28	.....	.....	.57	.....	164.32	455.41	52.80	80.00	54	30
43.65	20.30	13.85	.....	.....	8.31	6.34	3995.90	4138.70	105.00	105.00	.....	.....
.....	.....	.....	.....	.....	... .	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	... ..	.....	.....	.....	.....	.....	.....	.....
0.51	3.12	1.74	1.01	.....	0.17	.....	271.00	336.00	80	92	.....	.....
1.15	4.83	7.15	.50	2.88	1.36	.....	981.22	903.94	94	100	.....	.....
6.86	9.28	10.11	19.14	0.51	.....	.....	2257.45	2165.45	80	80	.....	.....
2.22	0.15	0.63	5.97	.....	.....	.....	617.50	443.50	66	66	.....	.....
4.88	4.45	4.95	1.33	13.66	.....	.....	1515.40	1523.20	80	80	.....	.....
6.79	6.90	11.28	9.37	.....	.....	.....	1760.00	1470.00	66	66	.....	.....
11.25	8.24	17.03	22.86	.....	.....	.....	2766.22	2724.39	66	66	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
304.49	175.75	172.02	111.57	34.66	16.17	7.10	29994.74	30010.46	.....	.....	.....	.....

TABLE OF ROLLING STOCK AND MOTIVE POWER OWNED BY TEXAS AND PACIFIC RAILWAY COMPANY, FEBRUARY 25, 1874.

Motive Power.

DESCRIPTION.	NO.
Locomotives	30
Switchers	1

Rolling Stock.

DESCRIPTION.	NO.
Officers' Coach	1
Passenger Coaches	14
Contractor's Coach and Baggage	2
Baggage, Mail and Express	5
Baggage	3
Box	131
Flat	240
Stock	25
Wrecking Car	1
Caboose Cars	2
Pile Driving Car	1
Hand Cars	48
Push Cars	3
Iron Cars	13
Boarding Cars	3

COMPARISON OF UNION AND CENTRAL PACIFIC AND TEXAS AND PACIFIC GRADES.

Union & Central Pacific.	Miles.	Texas & Pacific.	Miles.	Difference in favor of T. & P. Railway.	Miles.
Between 66 & 90 feet per mile,	199.95	Between 66 & 90 feet per mile,	120.82	Between 66 & 90 feet per mile,	79.13
" 90 & 105 " " "	29.45	" 90 & 105 " " "	7.10	" 90 & 105 " " "	22.35
" 105 & 116 " " "	29.45	" 105 & 116 " " "		" 105 & 116 " " "	29.45

ELEVATION OF SUMMITS.

Union & Central Pacific. Summits.	Feet.	Texas & Pacific. Summits.	Feet.	Difference in favor of T. & P. Railway. Feet.
Evans' Pass, Summit Rocky Mountains,	8,235	Hurd's Pass, Guadaloupe Mountains,	4,419	3,816
Dodge's Summit, Divide of Continent,	7,100	Summit of Continent,	4,893	2,207
Rim of Basin, Wasack Mountains,	7,546	Nugent's Pass,	4,709	2,837
Salt Lake Basin,	4,200			
Promontory,	4,961			
Pequos Pass,	6,180			
Toana Pass,	6,100			
Dormer Pass, Sierra Nevada Mountains,	6,988	San Gorgonio Pass, Sierra Nevada Mts.,	2,621	4,367

DISTANCES.

Route.	From	To	R. R. Line.	Air Line.	Distance Lost.
Union & Central Pacific.	San Francisco.	Omaha.	1,907 miles.	1,380 miles.	527 miles.
Texas & Pacific.	Shreveport.	San Francisco.	2,020 "	1,650 "	470 "
Texas & Pacific.	Shreveport.	San Diego.	1,657 "	1,325 "	332 "

EARNINGS.

The three Divisions (525 miles) east of Fort Worth will earn at least $5,000.00 per mile per annum; and if emigration continues to fill up the country on these Divisions, the earnings will gradually and permanently increase.

The Eastern part of the State, through which the line runs, is heavily timbered with pine, oak and cypress. The Western portion is about two-thirds prairie. The local demand for lumber in this portion, for many years, will balance the heavy transportation of cattle, cotton and grain from the West to the East, which, in connection with the travel over these Divisions, East and West, covering by its connections the whole of the densely populated portions of Northern and Western Texas, will give the line in Texas a large, remunerative and steadily increasing traffic.

When the agricultural and grazing lands, yet comparatively unsettled, are filled with population, and which are susceptible of the highest cultivation for 300 miles West of Fort Worth, a large traffic must accrue to the Road; which even with the present settlement along the line, would give a revenue of $2,500 per mile, and which will be largely increased as soon as we reach the coal fields on the Clear Fork of the Brazos River.

When we reach El Paso (Fort Bliss) we shall control the trade of Chihuahua (Mexico), a country which is rich in minerals and has a large pastoral and agricultural population, and their trade will add largely to our revenue.

That portion of the road in New Mexico and Arizona will receive a large traffic already existing there. It will open up and develop the rich mineral resources of that country, and will also draw a large portion of trade from Southern Colorado and Utah. As soon as we build far enough West to secure and control the trade of the northern portion of Old Mexico, it will add largely to our revenue.

The road, completed, will have its through business and local business, and a moderate estimate will bring its net earnings up to $2,000 or $2,500 per mile, and from the time of its completion will increase gradually and permanently.

The question as to whether the earnings during its construction will pay running expenses and interest upon bonds

issued upon completed road, is one that I am not able to fully determine. I believe, however, from the time of commencement to the completion, that while a portion of the line will not earn sufficient to pay the interest upon the bonds issued upon completed road, yet, upon a final completion of the road, it will be found to have earned very nearly enough to pay the running expenses and the interest, especially if the latter does not exceed $2,000 per mile per annum.

As to the payment in its entirety, it has to-day ten times the local business that the Union Pacific had in its infancy—a road now earning $10,000 per mile per annum, and paying an interest of $4,000 per mile per annum, and whose local business has been increased 50 per cent. yearly, and this with a large portion of its land so high in altitude (being from 5,000 to 8,000 feet above the level of the sea) that its lands are not susceptible of cultivation; while the Texas and Pacific is, for nearly its entire route, below 4,000 feet in altitude, and except at the Guadaloupe Mountains and the Divide of the Continent, we maintain our line between sea level and 4,000 feet above the sea for a distance of 1,985 miles.

As a feeder to this line, the business of Old Mexico cannot now be estimated, but the national topographical features of North Mexico indicate that all its business and traffic will naturally tend to us, and ere long branches, feeders to our line, will extend through its mining and agricultural districts, even to the gulf.

COMMERCIAL VALUE.

The Texas and Pacific Railway, once completed, brings into active life the whole Southern system of Railroads, now weak and struggling for life for the want of through traffic and a proper terminus.

The completion of the Union and Central Pacifics built up rapidly the entire system of Railroads north of the Ohio and east of the Missouri Rivers; many of them bankrupt, and all of them west of Chicago struggling under heavy debts.

The terminus it gave them on the Pacific Ocean, with the trade of Australia, China and Japan as feeders, brought to the Union and Central Pacific a business that pays in tolls over $26,000,000 per annum. It has been estimated by our leading Railway Managers that it brought a business that

paid to the roads east of the Missouri River not less than $75,000,000 in revenue.

Applying this experience to the line parallel with the Roads south of the Ohio River and east of the Mississippi—with the Texas and Pacific completed to San Francisco and San Diego, creating an immense local traffic of its own, competing for and creating the new business from foreign countries that competition always develops—it would give this Road one-half the revenue of ten or twelve millions, and turn this amount of business on to the Southern system and they would then become paying roads.

There is no future for the Southern system of Railroads unless the line on the 32nd parallel of latitude is completed, giving them an outlet to the Pacific and the command of the trade of the Southern Territories and Old Mexico.

Place the Railroad system of the North in the same position to-day as the system of the South, and their interest, capital and business would be demanding and enforcing the completion of the Southern Pacific Railroad.

Both systems have been predicated upon a through route across the Continent. One has been built by the government, leaving the other half completed and the private capital invested in connecting lines sunk or crippled.

There is but one solution to this problem, and that is: The Government should give the road such aid as to enable it to go forward to a rapid completion; develop the Zone across the Continent that now lies dead for want of means of communication, and by developing it, bring into active competition and life the whole system of improvement south of the Ohio River.

MILITARY VALUE.

The Texas & Pacific Railway once built, the borders of Texas, New Mexico and Arizona, now so dangerous to the few and scattered inhabitants on account of exposure to Indian raids, would become safe, and the large United States force maintained in the vicinity of the road at a heavy annual cost to the government, could be dispensed with, and an annual saving to the government effected of an amount equal to the interest on the capital required to build the road.

During the entire time that the Union Pacific was under

construction, the Indians were at war, continually committing depredations, killing and scalping. The advance of the track into the Territories made all parts of the country in its rear safe, and finally brought to peace every tribe of Indians in the Territories through which it ran. The same would be the case here, and done so quietly and silently that no one would be able to fix the date of its accomplishment.

Texas would fill up with emigration, and the tribes would settle down on their reservations or drift West, and the same results would be repeated as we advanced into and through each Territory.

As a matter of defence, the construction of the Texas & Pacific Railway would be the cheapest and most effective method the government could adopt. As a matter of economy, it will save to the government, yearly, millions of dollars; far more than the amount of interest on the amount of capital required to build it. From Fort Worth to California it runs through a country now almost entirely over-run with hostile Indians, and only inhabitable under the protection of the military forces. Hundreds are killed yearly by the raids of the Cheyennes, Comanches, Kiowas, Apaches and others, and a vast amount of property destroyed and driven off, which necessitates the maintenance of numerous Military Posts by the Government. The iron once laid on the Texas and Pacific Railway, these troubles will be promptly and permanently settled. The experience of the Government in this has been ample.

CONCLUSION.

The Texas & Pacific Railway opens up to settlement a vast undeveloped agricultural and mineral region, now only unavailable from the want of the means of cheap and quick communication and transportation. It secures to the government a lasting and permanent peace with the hostile Indian tribes. It will bring us in direct communication with Mexico and open up an extensive trade which has heretofore sought other countries. It is a line of even temperature—no snow, no extremes. It is the shortest Railroad communication from sea to sea—1,460 miles from harbor to harbor, against 3,300 miles by any other line.

The Union Pacific is a Central Northern line, gives a great

advantage in trade and access to Northern Cities, and is the great feeder to Northern Railroads.

The Texas and Pacific would become the feeder of the general system of Railroads running through the South, and would bring into competition the two great Systems of the Continent, and bring all the means and advantages of the Southern System to the development of the trade through the Southern States and Territories, and allow their roads to compete on equal terms for the trade of the Pacific Coast and all other Countries whose trade seeks its harbors.

It is the shortest way to Europe from Australia, India, China and Japan—the distance from San Diego to Nangasaki, Japan, 5,709 miles; San Diego to Shanghai, China, 6,264 miles; San Diego to Hong Kong, China, 6,850 miles; San Diego to Sydney, Australia, 15,900 miles.

To accommodate this trade, we have at San Diego a completely land-locked harbor, as safe as any in the world. Vessels drawing 26 feet of water can come alongside our wharves at all stages of water. The channel of the harbor is twelve and a-half miles long and about half a mile wide, the water varying in depth from 20 to 51 feet, giving ample room for a fleet of 1,000 first class ships to ride at anchor.

It is the shortest and most direct line across the Continent, is of low grades and light curvatures, and passes all the great mountain ranges to the south, or overcomes them at light grades and low altitudes below the snow limit. It develops a vast extent of country, without any natural means of communication, which can be reached in no other way. It settles the Indian question, as along its line is the only territory infested by hostile bands of Indians, and dispenses with a long line of frontier defences, and will save to the government at least five million dollars annually, as experience has proved that a railway line through Indian Territory is a fortress as well as a highway.

* * * * * * * * *

Upon my Chiefs of Divisions most of the work has devolved. They have carried out their instructions with alacrity, ability and good judgment, and often under difficulties that would have deterred most men. They have all found a line over their respective divisions far superior to any that was supposed to exist;

especially is this the case with the line over the Sierra Nevada Mountains and the Guadaloupe Range, and these were only determined after months of continued examination and *reconnoissances.*

Since July, 1872, the surveys have been extended from the Red River in Texas to the Pacific Ocean, in the general direction of the 32nd parallel of latitude, exploring a country 200 miles in width, developing its resources, bringing to light its hidden treasures, and fully demonstrating its capability for building and sustaining a railroad to the Pacific Ocean.

The country has been systematically developed, explorations have been pushed to success, and one after another of the engineering obstacles supposed to exist to the building of the Southern Pacific Railway have been met and overcome; the route of the road has been definitely fixed and unquestionably is the best to be had across the continent, in the zone which has been explored. I desire to extend my thanks for the courtesies and aid extended to me at all times by the military under Generals Augur and Pope, and the officers and troops have cheerfully extended us all the aid and protection we desired.

I desire to call the attention of the Company to the able and effectual manner in which Mr. R. S. Hayes, Engineer in charge of Construction, and Messrs. Evans, Walcott, Hurd, O'Neill and Hodges, Engineers in charge of Surveys, and J. M. Eddy, Assistant Superintendent, and the Heads of Departments and subordinates, have performed their duties, and the fidelity with which they have executed their trusts.

LAND DEPARTMENT.

The lands that the Texas & Pacific Railway Company will be entitled to upon the completion of the line are, as heretofore reported, 32,051,200 acres, distributed as follows:

From the State of Texas, 13,670,400 acres; from the United States in New Mexico and Arizona, 14,899,200 acres; from the State of California, 3,481,600 acres.

The lands in Texas to be located inside the reservation, are 6,322,000 acres; outside reservation, 7,348,400 acres.

There is due us from the State of Texas, for the Road completed to date, 3,436,800 acres.

There have been surveyed to date, 847,000 acres.

There are 207,000 acres belonging to the Company inside the reservation that were surveyed by the Memphis & El Paso Railroad Company, but the work was so imperfectly done that at least one-half of it will require re-surveying before certificates can be filed for it.

There are at present seven parties in the field making the surveys, preparatory to taking up the lands that are due us or completed road.

The quality of these lands has been fully described in a former part of this report. All those lying in Texas are valuable as agricultural and grazing lands; of those in New Mexico and Arizona, two-thirds as agricultural, grazing and mineral lands; in California, about one-half as agricultural, grazing and mineral lands. The great bulk of these lands is not available, except as the Road progresses through them, but will eventually become a source of large revenue to the Company.

I estimate the value of the lands east of the 100th meridian, by the time they are all sold, to average $5 per acre; west of the 100th meridian to the Rio Grande, at $3 per acre; through New Mexico, $2.50 per acre; through Arizona and California, $1.25 per acre. At this estimate, they would bring to the Company about $50,000,000.

TOWN LOT DEPARTMENT.

In connection with the Land Department, there was established a Town Lot Department, for the purpose of obtaining and laying out the Depot Towns along the line of the road. Up to this time it has been found to work very successfully, and as we go West I have no doubt it will be a great aid to the settlement of our lands. I submit a table showing the names of towns, number of lots donated for public purposes, number sold, average price per lot, cash receipts, bills receivable and total sales.

It will be seen that during the year 1873 the total receipts amounted to $18,760.20, of which $11,781.95 was cash, the balance notes payable in 1874 and 1875, with interest at 10 per cent. per annum. The total cost was $5,555.71, showing a net profit of $13,204.49. They have been sold at an average of $124.24 per lot, and a net profit of $87.45 per lot. In a large portion of these towns, few sales have as yet been made, not

having been in the market long enough, and the country near them being sparsely settled; but as the country fills up these towns will grow, our sales will increase yearly and be a benefit to the road and to the country.

The towns have been laid off uniformly into lots, blocks, etc., numbered upon a general plan, and are either deeded to the Texas & Pacific Railway, direct, or through a trustee. In a number of cases parties owning lands where towns were located, have been allowed to retain an interest in the towns, with a view of getting the local aid of people living at or near the town.

TOWN LOT DEPARTMENT. CONDENSED STATEMENT, 1873.

NAMES OF TOWNS.	No. Donated.	No. Sold.	Average Price Received per Lot.	Cash Receipts.	Bills Receivable.	Total.
Hallville . .	2	2	$25 00	$50 00	$	$50 00
Longview .		13	71 15	925 00		925 00
Gladewater .		2	135 00	270 00		270 00
Hawkins . .	16	4	93 75	200 00	175 00	375 00
Wills P'nt.		23	117 75	2,108 85	602 50	2,711 35
Elmo		13	122 10	850 00	737 50	1,587 50
Terrell . . .		41	98 66	2,718 80	1,326 50	4,045 30
Brooklyn .	12	6	108 33	375 00	275 00	650 00
Mesquite .		2	162 50	162 50	162 50	325 00
Moore's L'g.		2	100 00	100 00	100 00	200 00
Texarkana .		20	280 00	2,925 00	2,675 00	5,600 00
Savoy		23	87 87	1,096 80	924 25	2,021 05
	30	151	$124 24	$11,781 95	$6,978 25	$18,760 20

Total am't Vouchers, ... $5,555 71
Net Profits, ... $13,204 49
" " per Lot Sold, ... $87 45

Respectfully submitted,

G. M. Dodge, *Chief Engineer.*

OFFICE OF ENGINEER OF CONSTRUCTION,
Marshall, Tex., March 1, 1874.

GEN. G. M. DODGE, *Chief Engineer:*

DEAR SIR,—In compliance with your instructions, I beg to submit the following report of the operations of this Department in the construction of the lines diverging east from Fort Worth.

These lines, for convenience of construction, were made to consist of the following Divisions: —

SOUTHERN DIVISION.

Shreveport to Fort Worth, distance 219 miles, with head-quarters and depot of supplies at Marshall, and the division was made to cover the 66 miles of road from Shreveport to Longview, already in operation, and includes entire construction from Longview west; also four and a half miles of work at Jonesville, known as the Cut-off.

JEFFERSON DIVISION.

Sixty-nine miles, from Marshall via Jefferson to a junction with the East half Trans-Continental Division, five miles west of Texarkana, having head-quarters at Jefferson.

EAST HALF TRANS-CONTINENTAL DIVISION.

Texarkana to Paris, distance 91 miles, via. DeKalb and Clarksville, with the same head-quarters and Division organization as the Jefferson Division, and using Sherman and Marshall as depots of supplies.

WEST HALF TRANS-CONTINENTAL DIVISION.

Paris to Fort Worth, distance 145 miles, via Honey Grove, Bonham, Sherman, Pilot Point and Denton.

A total of 524 miles, inclusive; 66 miles in operation.

Location was commenced in the early summer of 1872, and completed in the fall of the same year, although in some instances the work was let and contractors were on the ground before the details were completed. In the location no especial difficulty was experienced, the greatest altitude being only feet and the highest elevation feet above mean Gulf tide. Certain towns designated by the State Charter and conditional

local subsidies, as Dallas, Sherman, Bonham, Honey Grove, Paris, Jefferson and Marshall, determined the location, and the line was to be placed upon the most practicable country between them. The country is generally rolling, that between Longview and Sabine Crossing on the Southern Division, and Jefferson to Sulphur on the Jefferson Division, being the most broken and abrupt.

The minor divides, crossed between the side drainages of the principal streams, are frequently at as great an elevation as the main divide, making many altitudes to be overcome in reaching a principal summit, each nearly as great as the total distance to be gained, as shown by the table of grades.

THE SOUTHERN DIVISION.

Starts from the Red River at Shreveport, La., running thence through Caddo Parish, and enters the State of Texas in Harrison County, crossing the divide between the waters of Red and Sabine Rivers near Marshall, the county seat; thence following up the valley of the Sabine, crossing its various side drainages of Gladewater, Big Sandy, Lake Fork, Red Oak, &c., it crosses the Sabine River at a point 50 miles west from Longview into Kaufman County, ascending to Wills Point, where it drops over into the drainage of the east fork of the Trinity, which stream it crosses near Forney, 18 miles east of Dallas. At Dallas main Trinity River is crossed, just below the junction of the West Fork, which branch is followed to Fort Worth at the junction of the west and clear forks of the Trinity, and diverging point of the Trans-Continental Division.

JEFFERSON DIVISION.

The line was made to adhere to the old Memphis and El Paso location, whenever advantage could be taken of the work, partially completed by that Company. A small amount, however, in quantity, but stretching in distance over a considerable portion of the Division. From Marshall the line runs a little east of north to the City of Jefferson on the Big Cypress Bayou, which flows into Red River; thence due north, following the incomplete work of the M. and E. Co. for about 22 miles, it reaches the Sulphur River at Moore's Landing, 57 miles north of Marshall, crossing that stream upon a pile bridge 7,960 feet

long, the sub-structure of which was constructed by the Southern Trans. Railroad Company, successors to the M. and E. Co.; thence the line follows the incomplete road-bed of the M. and E. to its junction with the east half of the Trans-Continental Division, five miles west of the State Line and 69 miles north of Marshall.

The line is in the country draining to the Red River, and crosses all its principal streams flowing from the west and their tributaries, the three Cypresses, Black, James, Williams, Bakers, Sulphur River and other minor streams.

THE TRANS-CONTINENTAL DIVISION.

Starting from the north east boundary line of the State, separating it from Arkansas, at Texarkana, the point designated by the Commissioners of the Cain and Fulton and Memphis and El Paso Railways for their junction. The line runs almost due west, keeping the crest of the divide between the Red River and Sulphur and adhering to the road bed of the M. and E. for about 40 miles (constructed by that Company 15 years ago), passing through Dekalb, Clarksville, Paris, to Honey Grove, 113 miles west from Texarkana. The line then drops into the Red River drainage, crossing Bois d'Arc Caney, Brushy, Choctaw and their tributaries, passing through the towns of Bonham and Sherman, and regains the crest of the divide five (5) miles west of the latter place. Thence diverging to the south, it crosses into the drainage of the branches of the Trinity, and follows the west side of the divide between Elm and East Forks, crossing the Elm, Hickory and Denton in Denton County, and the West Fork in Tarrant County a mile east of Fort Worth, near which point it joins the line of the Southern Division.

I here insert table of grades from Shreveport to Fort Worth, Marshall to Texarkana Junction and Texarkana to Fort Worth. You will perceive that all grades above 66' per mile occur on the Old Road between Shreveport and Longview and on the Jefferson Division; also please find attached table of quantities upon which the cost of the road was based.

TEXAS & PACIFIC RAILWAY UNDER CONSTRUCTION.

TABLE OF GRADES.

CURVATURE 107° 6'.	Miles.	ASCENDING WEST. GRADE PER MILE IN FEET.						Level Grade.	DESCENDING WEST. GRADE PER MILE IN FEET.						Ascent. Feet.	Descent. Feet.	MAXIMUM GRADE.	
		0 to 20	20 to 40	40 to 60	60 to 66	66 to 80	80 to 100		0 to 20	20 to 40	40 to 60	60 to 66	66 to 80	80 to 100			Ascent.	Des'nt.
Shreveport to State Line	19.37	1.12	2.29	4.34	28	27		4.62	51	3.12	1.74	1.01		17	271.00	336	80	70
State Line to Longview	44.18	1.45	3 26	5.32	2.35	4.22	82	8.86	1.15	4.83	7.15	50	2.88	1.36	981 00		94	
Longview to Dallas	124.50	6.64	12.97	12 92	18.23	50		27.34	6.86	9.28	10.11	19.14	51		2.165.45		80	
Dallas to Fort Worth	30.31	95	3.27	2.73	5.77			9.12	2.22		63	5.97			617.50		66	
Marshall to Junction	69.04	4.60	4.33	5.13	1.80	3.44		10.47	4 88	4.45	4.95	1.33	18.66		1,515.40		80	80
Texarkana to Paris	90.18	12.11	8.99	11.04	12.48			12.02	6.79	6.90	11.28	9.37			17.60		66	66
Paris to Fort Worth	145.18	8.21	1.36	10.69	27.38			28.11	11.25	8 24	17.03	22.86			2,766.22		66	66
	524.40	35.08	46.47	52.17	68.29	18.43	1.53	100.54	33.66	36.97	52.89	60 18	17.05	1.53	10,168.40	9,566.48		

TEXAS & PACIFIC RAILWAY UNDER CONSTRUCTION.

ESTIMATED QUANTITIES.

	Miles.	Clearing Acres.	Grubbing Stations.	Earth Excavation. C. Yards.	Classified Excavation. C. Yards.	Bridge Timber. Feet B. M.	Piling. Lin. Feet.	Cross Ties. No.	Iron and Spikes. Lbs.	Truss Bridge. Lin. Feet.	Masonry. 1st Class.	Masonry. 2nd Class.	Masonry. 3rd Class.	Tunnelling.
SOUTHERN DIVISION.														
Longview to Fort Worth	153	1,587	2,340	2,854,000	106,432	952,683	162,172	424,324	84,546	1,220	.....	.....	.....	.....
JEFFERSON DIVISION.														
Marshall to Tex. Junction	69	423	526	832,482	414,501	760,628	71,804	182,144	44,989	.....	.....	.....	.....	.....
TRANS-CONTINENTAL DIVISION.														
Texarkana to Paris	91	650	931	552,009	.....	1,073,952	28,164	240,117	20,538	.....	.....	.....	.....	.....
Paris to Sherman	64	241	294	864,071	9,363	1,932,289	96,367	173,890	58,712	.....	.....	.....	.....	.....
Sherman to Fort Worth	81	428	427	1,051,963	73.637	2,427.539	130,277	210,271	84,048	825	.....	.....	.....	.....
	458	3,329	4,518	6,154,525	135,093	9.147 091	488,784	1,230,746	292,833	2,045	.....	.....	.....	.....

The country through which these lines pass affords ample material for construction—the timber and prairies having each their peculiar characteristics, and their division is most clearly defined. For 150 miles west from Shreveport, the Southern Division passes through the oaks, pines and other timbers coincident with that section of the State—the pine being generally of better quality in the Sabine drainage ; thence west to Fort Worth, with the exception of a belt of post oak called the "Cross Timbers," between Dallas and Fort Worth, about 12 miles wide, and the timber bordering the streams, the line lies upon the rich black soil of the prairies.

The Jefferson Division is wholly within a timber country, affording pine, cypress and the best of oak.

THE TRANS-CONTINENTAL DIVISION,

For the first 100 miles west from Texarkana, has the post oaks of Bowie County and the pines of Red River and its tributaries; from thence in the prairie to the Junction at Fort Worth, except the Cross Timbers in Denton County.

The rock is said to be tertiary, and in the prairie is a soft friable limestone, underlying the soil, disintegrating upon exposure, although in some localities it is hard, compact and suitable for building purposes. In the timber there was found an amorphous sandstone, highly colored with oxide of iron, but most frequently in small quantities, scattered upon the surface, and seldom showing a quarry face; with it is generally mixed a coarse conglomerate or red hematite ore, the latter existing in certain localities in working quantities. Lignite is also frequently found in the timber, showing on the bluff face of streams, but none that I have known of commercial value.

WATER SUPPLY

Is ample and not expensive in obtaining, the timber country affording wells, springs and running streams. In the prairies resort is had to excavation and damming heads of drainages, for reservoirs of sufficient capacity to supply through the ordinary drouths of summer.

CONSTRUCTION.

On the lines hertofore described, construction was commenced on the Southern Division at the town of Longview, in

Gregg County, the terminus of the Southern Pacific Railway, and extended west; also covering the new work on the Jonesville cut-off, and the general repairs of the line in operation east of Longview. On the Jefferson and E. ½ Trans-Continental Divisions, the old grade taken advantage of was completed; but with the exception of the substructure of the Sulphur River Pile Bridge (recently constructed), all the culverts and ties were removed to make room for new structures. The West ½ Trans-Continental was also let from Paris to a point five miles west of Sherman. In the estimate of cost, no allowance was made for the quantity or cost of the old work used, but the cost of repairs necessary to complete it was estimated.

I here submit the estimate of cost which has been furnished previously, and the results upon the work completed show that they amply covered the expenditures. (*See next page.*)

On account of the scarcity of building stone adjacent to the lines, no actual quarries being found, the idea of using masonry in the rapid construction required was abandoned, and box and log drains, constructed of the most lasting timber the country afforded, were substituted for the small openings. Piles were used in every case where they could be driven; and in all trestle bridging, the bents, with the above exceptions, rested upon piles firmly stayed and strapped. The test blow for piling required that the pile should not drive over 2 inches under a 20 feet fall of the lightest hammer permitted to be used, (1,800 lbs.) The driving was carefully inspected, and the results from the bridges in use for the past year are most gratifying. The bents of all pile and timber work were made 18 feet between centers, and chords of three (3) pieces, each 6x14, carefully packed and bolted, were used as stringers. The single and double deck trestles were constructed, as is usual, of 12x12 timber well stayed and braced. The truss bridges were of the Howe style, and were framed of Calcasieu and in two cases of Northern pine, both chords of timber calculated for a rolling load of 3,000, with a factor of safety of 6.

The Depots, Section and Round Houses were made of simple construction, to suit the latitude, resources of the country and requirements of the Railway, and, as far as possible, of a style to please the eye.

The large shops at Marshall were built upon general plans

TEXAS & PACIFIC RAILWAY.—ESTIMATED COST.

	Miles	Clearing and Grubbing.	Earth Excavation.	Classified Excavation.	Bridging.	Tracklaying and Ties.	Buildings.	Shops.	Water Supply.	Telegraph.	Engineering and Contingencies.	Transportation	Total Construction.	Average Per Mile.
SOUTHERN DIVISION.														
to Section 127	126	$68,682	$868,428	$68,984	$270,130	$269,604	$78,720	$256,704	$30,720	$25,200	$268,192	$34,076	$2,239,440	$17,773 33
to Fort Worth	27	16,875	151,531	20,000	45,279	58,752	8,991	.....	5,778	5,400	58,968	13,500	385,074	14,262 00
	153	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,624,514	17,153 68
JEFFERSON DIVISION.														
Marshall to Junction	69	27,669	220,310	68,524	121,854	139,656	26,634	5,727	15,525	13,800	132,825	19,665	792,189	11,481 00
EAST ½ TRANS-CONTINENTAL DIVISION.														
Texarkana to Paris	91	21,112	175,584	3,952	65,884	184,366	42,315	18,746	24,752	18,200	140,686	47,320	742,917	8,163 81
WEST ½ TRANS-CONTIN'AL DIVISION.														
to Sherman	64	10,176	198,373	41,383	168,192	156,032	43,584	7,424	17,984	12,800	127,744	12,800	796,972	12,453 00
Sherman to Fort Worth	80	17,091	249,995	25,000	267,462	172,206	24,624	.....	15,228	16,200	164,511	56,700	1,009,017	12,457 00
Division	236	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,548,906	12,224 17
1	458	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,965,609	13,025 34

LONGVIEW TO FORT WORTH.			MARSHALL TO TEXARKANA JUNCTION.			TEXARKANA TO FORT WORTH.	
Delivery.	Rolling Stock.	Iron. Spikes and Fastenings.	Real Estate and Right of Way.	General and Legal Expenses.	Charter Privileges.	Total Cost.	Total Average Cost Per Mile.
00	$604,000 00	$1.134,000 00	$25,200 00	$31,500 00	$12.600 00	$4,071,940 00	$32,316 19
00	108,000 00	243,000 00	5,400 00	67,500 00	2,700 00	756,324 00	28,012 00
.....	.....	.....	.....	.....	.....	4,828,264 00	31,557 21
00	276 000 00	621,000 00	13,800 00	17,250 00	6,900 00	1,740,939 00	24,941 00
00	364 000 00	819.000 00	18,200 00	22,750 00	9,100 00	1,994,167 00	21,913 92
00	256.000 00	576,000 00	12.800 00	16,000 00	6,400 00	1,676,992 00	26,203 00
00	364,000 00	729,000 00	16,200 00	20,250 00	8,100 00	2,122,767 00	26,207 00
.....	.....	.....	.....	.....	.....	5,793,926 00	24,550 00
.....	.....	.....	.....	.....	.....	12,363,129 00	26,993 73

approved by the President; the Round House, Car Shed and other buildings being reduced in proportion to the present requirements.

Three points had been selected as depots for supplies and bases of operation: of these, Dallas alone fulfilled the anticipated requirements of having unintercepted communication from without the State; this point, at the intersection of the Southern Division with the H. & T. C. Railway, being supplied from New Orleans via Galveston, although communication between it and Marshall was had by wire via New Orleans and Houston (two repeating offices), and by mail by stages and messengers for the first few months of construction. Sherman, the depot for the West ½ Trans-Continental and a portion of the East ½ Trans-Continental Divisions at the intersection of that line with the H. & T C. (65 miles north of Dallas), failed to have rail or wire communication with Galveston or St. Louis until February, 1873, five months subsequent to the commencement of construction, although fairly anticipated to have connection in the fall of 1872: in the interim, stages, wagons and messengers were the methods of supplying communication.

Marshall, acting as the general head-quarters and principal depot of supplies, depended upon the navigation of Red River for communication with St. Louis and New Orleans, via Shreveport, or a wagon haul of 110 miles, from the terminus of the North Louisiana and Texas Railway, a *dernier ressort* necessarily taken during three months of unprecedented low water in Red River, subsequent to the commencement of the work, and until relieved by the completion of the International & Great Northern Railway to Longview, bringing Galveston in direct rail and river communication with Marshall.

Jefferson was also made a distributing point for supplies and material for 60 miles of that Division, in compliance with the conditions of the subsidy voted by that city and Marion county. To carry out the rapid construction designed, four points, Sherman, Dallas, Longview and Marshall, were selected for the collection and storage of track material, and from which four track laying forces were to simultaneously commence, and push rapidly forward until two met upon each line. The work was let, and arrangements for time of completion made with that in view.

The stringent requirements of the charter and subsidy granted by the State of Texas, that the lines East of Fort Worth should be completed and in operation by January 1, 1874, permitted no time to be used in perfecting organizations, plans and the usual details.

Proposals for the letting of the work by October 1, 1872, were solicited by advertisement during the previous summer.

This Department was organized on October 4, 1872, and sufficient contracts let from the 6th to the 10th to secure the completion in accordance with the above charter requirements, and comply with the conditional subsidies of the several towns and counties granting the same.

During the following month of November the contractors obtaining work were upon the ground with organized forces, and construction was fairly commenced, the force reports for that month showing some 2,800 teams and 3,000 men upon the line, irrespective of those employed in camps, mills, transportation, etc.

In anticipation of the scarcity of labor within the State, agents were sent to the Southern States to forward negroes, and contracts made for Chinese; 250 of the latter were placed upon the Jefferson Division. The demand created, however, soon supplied itself; and the Chinese, not proving profitable, were dispensed with.

The collection at the depots within the State of the large quantities of necessary tools, supplies and material, and the short time for obtaining ties, bridge timber and lumber, were anticipated as far as any ordinary difficulties attending could be apprehended. The introduction of a large number of saw mills obviated the latter difficulty, and reliable and rapid communication between points in the State was secured by the completion of the telegraph line from Marshall to Sherman, 218 miles in length.

Specific causes hardly to be apprehended were encountered making the difficulties of obtaining supplies, machinery, material, tools, etc., from without the State, most serious, and at the time rendered progress doubtful.

Communication via Red River, mainly depended upon as the only means of transportation without wagon haul, in the eastern portion of the State, almost entirely failed by its low stage of

water for nearly five months succeeding the commencement of work in October, 1872.

The anticipated connections at Longview and Sherman by rail were also delayed four months beyond expectations. When the only resources for obtaining supplies were by wagon haul from Monroe to Shreveport, 110 miles, and from the terminus of the International and Great Northern Railway, the epizootic appeared as an epidemic and for a short time stopped progress at points, and at the same time small-pox broke out on the Eastern portion of the Southern Division.

The extension of time granted by the State of Texas in the spring of 1873, somewhat altered the original designs, and only three track forces were started—at Dallas, Longview and Jefferson—the track at Sherman awaiting the completion of the Southern Division to Dallas.

I here present tables showing the amount of track laid on each Division (including sidings), description of buildings erected on each Division, description of water stations on each Division, and the description of the bridging on each Division, with other information concerning the road.

The road-bed is graded, bridged, and the ties on the line, ready for the track from five miles east of Texarkana to Brookston 8 miles west of Paris, distance 94 miles.

SOUTHERN DIVISION.—STATE LINE TO TRINITY RIVER.—TRACK AND BUILDINGS.

SIDINGS.	Miles. Sidings.	Miles. Main Line.	DESCRIPTION OF BUILDINGS.
Track on Main Line...	....	169.$\frac{120}{1000}$	
Waskom...	0.298	.....	
Jonesville	.244	.....	
Scottsville..... .	.280	.....	Depot, 20′ x 40′, frame.
Marshall.....	2.300	.....	Machine shop, brick, 2 stories, 70′ x 214′, and 2 wings, 70′ x 153′. Car shop, 9 stalls, fr., 60′ I. T. Round house, 10 stalls, fr'e, 60′ I. T. Blacksmith shop, 100′ x 70′, frame. Fr't and Pass. Depot, 120′ x 52′, frame. Warehouse, 120′ x 42′, frame. 1 office, 36′ x 44′, " General office, 3 stories, 80′ x 46′, frame.
Old Mill.....	.047	.....	1 car shop, 60′ x 100′, frame. 1 round house.
Taylor's Mill.....	.064	.....	Machine shop, 30′ x 160′, L., 30′ x 18′.
Hallville	.444	.....	Blacksmith shop, 30′ x 160′, Wood, I. T.
Mason Springs.....	.181	.....	
Longview	.384	.....	I. R. R. Junc., Union Depot, 30′ x 50′, and 1 story, 25′ x 25′, frame. Fr't and Pass. Depot, 197′ x 35′, frame.
Willow Springs.....	.151	.....	
Gladewater.....	.275	.....	Fr't and Pass. Depot, 20′ x 60′, frame.
Mill, No. 1.....	.152	.....	
" " 2.....	.075	.....	
" " 3.....	.094	.....	
Big Sandy Cr.....	.156	.....	
Hawkins.....	.492	.....	Fr't and Pass. Depot, 20′ x 60′, frame.
Lake Fork.....	.151	.....	
Minneola.....	.374	.....	Fr't & Pass D't, 22′ x 100′, fra'e.
Silver Lake.....	.155	.....	
Grand Sabine	.295	.....	" " " 20 x 60 "
Stevenson	.304	.....	" " " 15 x 30 "
Wills Point.....	.329	.....	" " " 20 x 60 "
Elmo.....	.342	.....	" " " 15 x 30 "
Terrell.....	.399	.....	" " " 20 x 60 "
Forney.....	.304	.....	" " " 20 x 60 "
Mesquith	.254	.....	" " " 15 x 30 "
Dallas.....	1.841	.....	Warehouse, 50′ x 150′, fr'me. Round house, 5 stalls, " Pass & Fr't Depot, in the city, 25′ x 150′, frame. 1 turntable, wooden.
Miles, Siding	10.$\frac{385}{1000}$	10.385	
Total.....		179.$\frac{505}{1000}$	

Section Houses between State Line and Dallas.

W½. TRANS-CONTINENTAL DIVISION.

BROOKSTON TO SHERMAN.

TRACK AND BUILDINGS.

SIDINGS.	Miles.		DESCRIPTION.
Track on Main Line....	.....	56.18	
Sherman.....	1.70	.....	Pass. Depot, 32′ x 60′, frame.
"	.....	.....	Fr't " 158 x 28 "
Choctaw.....	0.27	.....	
Savoy.....	.37	.....	Pass. & Fr't Depot, 25′ x 75′, frame.
Bonham.....	.70	.....	" " " " 25 x 100 "
Dodd City.....	.36	.....	" " " " 20 x 60 "
Honey Grove.....	.38	.....	" " " " 25 x 75 "
Brookston	.34	.....	" " " " 15 x 30 "
Total Sidings.....	.....	4.12	
Total.....	.....	60.30	

JEFFERSON DIVISION.

MARSHALL TO TEXARKANA.

TRACK AND BUILDINGS.

SIDINGS.	Miles.	Miles.	DESCRIPTION.
Track on Main Line....	....	74	
Woodlawn	0.307	.....	Fr't & Pass. Depot, 15′ x 30′, frame.
Jefferson.....	1.356	.....	" " " " 25 x 100 "
	.....	.....	Shop, 20 x 40 "
Monterey	.267	.....	Fr't & Pass. Depot, 15 x 30 "
Killdare	.323	.....	" " " " 15 x 30 "
Atalanta.....	.336	.....	" " " " 20 x 60 "
Lanark.	.220	.....	" " " " 15 x 30 "
Sulphur Mill.....	.157	.....	" " " " 15 x 30 "
Moore's Landing	.331	.....	Union Pass. House, 40 x 100 "
Texarkana	.993	4.29	Fr't Depot, 25 x 75 "
Total.....	.....	78.29	

WATER STATIONS.

LOCATION.	Capacity.	How Constructed.	Supplied by.	Source of Supply.
	Gallons.			
SOUTHERN DIVISION.				
Marshall	18,000	Iron tank, brick foundation.	Steam Pump.	Well.
" Shops	25,000	Wood tank in shop.	"	"
Hallville	8,000	Wood tank, fr'me, bri'k found'n	"	"
Longview	24,000	" " " " "	"	"
Glade Creek	24,000	" " " " "	"	Glade Cr'k.
Little Sandy	24,000	" " " " "	"	Lit. Sandy.
Lake Fork	24,000	" " " " "	"	Lake Fork.
Sabine River	24,000	" " " " "	"	Sabine Riv.
Grand Saline	24,000	" " " " "	"	Reservoir.
Wells Point	24,000	" " " " "	"	"
Terrell	24,000	" " " " "	"	Well.
Mesquette	24,000	" " " " "	"	Reservoir.
Dallas	24,000	" " " " "	"	Trinity R.
W. ½ TRANS-CONTINENTAL DIVISION.				
Sherman	18,000	" " " foundation.	"	Well.
Savoy	24 000	" " " "	"	Reservoir.
1 mile E. Bonham	24 000	" " " "	"	Well.
See No. 41	24,000	" " " "	"	Reservoir.
Three-Mile Creek	24,000	" " " "	"	Creek.
JEFFERSON DIVISION.				
Jefferson	18,000	" frame foundation.	"	Well.
1 mile N. Kildare	18,000	" " "	"	"
2 miles N. Atlanta	18,000	" " "	"	Creek.
Moore's Landing	18,000	" " "	"	"
Texarkana	18,000	" " "	"	"

BRIDGING.

SOUTHERN DIVISION.—STATE LINE TO TRINITY RIVER.

Stringer Bridges. Lin. Feet.	Box Drains. No.	Log Drains. No.	Cattle Yards. No.	Howe Truss. Lin. Feet.
30,831	25	18	35	4 spans, 80 feet.
.....	..	..	..	1 " 60 "
.....	..	..	..	2 " 100 "
.....	..	..	..	2 " 150 "
30,831 Lin. feet.	25	18	35	880 Lin. feet.

JEFFERSON DIVISION.

Stringer Bridges. Lin. Feet.	Box Drains. No.	Log Drains. No.	Cattle Yards. No.	Howe Truss. Lin. Feet.
25,456 Lin. feet.	.....	73	26	.....

E. ½ TRANS-CONTINENTAL.—TEXARKANA TO BROOKSTON.

Stringer Bridges. Lin. Feet.	Box Drains. No.	Log Drains. No.	Cattle Yards. No.	Howe Truss. Lin. Feet.
8,838	.....	106	18	.....

W. ½ TRANS-CONTINENTAL.—BROOKSTON TO SHERMAN.

Stringer Bridges. Lin. Feet.	Box Drains. No.	Log Drains. No.	Cattle Yards. No.	Howe Truss. Lin. Feet.
24,538	.....	16	40	170

ELEVATIONS.

Shreveport,	. . . . .	204 feet	above	tide	water.
Marshall,	. . . . .	377 "	"	"	"
Longview,	. . . . .	342 "	"	"	"
Dallas,	. . . . .	481 "	"	"	"
Fort Worth,	. . . . .	629 "	"	"	"
Jefferson,	. . . . .	226 "	"	"	"
Texarkana,	. . . . .	287 "	"	"	"
Sherman,	. . . . .	734 "	"	"	"

Highest Point on Southern Division, 16 miles East of Fort Worth. Elevation, ... 676 feet.

Trans-Continental Division, at Sherman, . . . 734 "

The conditions of the Dallas, Sherman and Jefferson subsidies were duly complied with, also such conditions of the State subsidy which acted by limitation, at previous dates.

In conclusion, I would beg to express my appreciation of the assistance rendered by Messrs. C. H. Irvin, E. D. Boyd and D. W. Washburn, Division Engineers, and of J. B. F. Sampsel, acting as Traveling Paymaster and Chief Clerk of this Department, by whose industry and ability the large detailed work of current monthly estimates and vouchers were kept in perfect system.

All of which is respectfully submitted.

R. SOMERS HAYES,
ENGINEER IN CHARGE OF CONSTRUCTION.

GENERAL INSTRUCTIONS.

PHILADELPHIA, June 15, 1872.

TO DIVISION ENGINEERS:

Blank forms for use in your Departments will be fowarded. All vouchers and pay-rolls must be made up in duplicate, and all returns must be accompanied by a statement.

A list of all property in the Engineering Department must be made out and receipted for by the Engineers in charge, and regular quarterly returns made to this office accounting for it.

All instruments must be furnished by the Engineers—the

Chief of Party a transit, and Assistant a transit or level. Whenever an Engineer leaves the party, if his instrument is needed by the party, he will be paid for it.

In case of purchase of instruments by the Company, they will be charged to Engineers receiving them and deducted from their salary. When transportation is furnished by the Company, it will be retained from the wages of an employee who leaves for any reason except discharge. Division Engineers will fix salaries of the parties except when otherwise directed. Salaries will be as follows:

Chief of Party, $175 to $200 per month; First Assistant, $125 to $150 per month; Second Assistant, $100 to $125 per month; Third Assistant, $75 to 100 per month; Rodman, $60 to $75 per month; Flagman, $40 to $60 per month; Laborers, $40 to $60 per month, and found in the field.

The strictest economy in all expenditures will be expected, and all bills will be examined and audited in this office before being allowed, and all employees will be held to a strict accountability for anything connected with the Road for which they are accountable.

G. M. DODGE,
CHIEF ENGINEER.

NEW YORK, May 23d, 1872.

GEO. R. WILSON, ESQ.,
DIVISION ENGINEER:

DEAR SIR,—In giving instructions to the parties making the surveys West of Fort Worth, you will use your judgment as to the country they should develop, being upon the ground and no doubt familiar with its topography. I lay down the following general rules, which I desire to be observed:

The party should be in charge of an engineer of experience, and who can intelligently grasp the situation, and leave his party whenever it is necessary to examine the surrounding country. His chief assistant must be competent to run the party and control it; and his experience, judgment and ability should be sufficient to give us what there is in the country they develop.

In building the Texas & Pacific we must have in view the commercial as well as the engineering qualities of the line. We want a road through Texas, which the country, when settled, is susceptible of supporting by its local trade when built. The party will therefore note carefully the quality and the capacity of the agricultural, grazing and mineral resources of each township and county through which it passes; also, if any one with the party is competent, its geology, and select specimens of its minerals, rocks, &c.; also note the character, location, quality and quantity of timber, and the water facilities on the line.

Pay particular attention to, and note particularly, the material for the construction of the road, of every kind—timber, ties, stone, gravel—in fact, everything that can be used; distance from the line, how accessible, where located, &c.

I not only want the particular country through which the line runs developed and mapped, but prominent points, mountains, streams, &c., fixed accurately by a system of triangulations, as the basis for a map, extending as far north and south of the line as the explorations necessarily extend; this is especially required, as no accurate map of the country exists.

I desire the line so developed, that the preliminary survey shall determine the most feasible route in the latitude through which the party run.

The topographer, or some other member of the party, under the direction of the chief, must keep a daily record of each day's work, noting whatever will be of importance hereafter.

With your main party, you should place a good engineer for *reconnaissance*, with one or two assistants, and move with pack mules, to examine the country north and south in advance of your main party. They can, by the barometer and a system of triangulations, examine summits and map the entire country, thus enabling your main party to advance rapidly and understandingly. The party taking the field must be armed, and the chief must be a man of energy and one who will not run at sight of an Indian. He must receipt for all property placed in his hands, and account for it in the usual manner. The party must work early and late, there being no stated hours in such work. The chief must make a weekly report of his progress when he has opportunity to do so, and at least once a month send rough maps on tracing paper, with profiles of his month's work, and whatever

suggestions and remarks in regard to the country he may deem proper, giving a general account of all matters pertaining to his line and statement of the facts.

The party will take one general line to develop; and if another must be run, we will either put another party into the field or be guided by circumstances when I come to Texas, some time in June next.

These instructions are general; you are not confined to them; you will add to them such others as your experience may deem best. If you cannot send me a profile of the located line to Fort Worth, so as to reach there by the 14th, send it to me at the New York office, where I shall be until the 18th of May.

* * * * * * * * March 20th, 1873.

As matters now look west of Phantom Hill, the Northern line across Clear Fork should be examined, if it has not already been done.

* * * * * * * * March 25th, 1873.

After Hubbard has run his direct route from the 100th meridian, you had better have him run down Paint or Clay Creek, and down Clear Fork to Griffin, or wherever it is necessary to avoid the heavy country from the divide between Clay Creek and the Brazos.

* * * * Mr. Hodges thinks that the two lines that are to come into competition are the Southern O'Neill's & Divide line and the Northern Cedar Creek & Brazos.

The line between Fort Worth and Weatherford also needs close attention; it will probably have to be re-run.

I am, respectfully,
G. M. DODGE,
CHIEF ENGINEER.

MARSHALL, TEXAS, May 12th, 1873.

JOHN O'NEILL, ESQ.,
FORT WORTH, Texas:

DEAR SIR,—I want you to re-examine the Northern line from Fort Worth and lay the line where a final location will go upon it. Start your party upon it at once.

I am very respectfully
G. M. DODGE,
CHIEF ENGINEER.

MARSHALL, TEX., June 1st, 1873.

GEN. G. M. DODGE,

CHIEF ENGINEER:

DEAR SIR, —On the 28th day of February, 1873, I submitted to Geo. R. Wilson, Division Engineer, a preliminary report of surveys to that date on the "Brazos Division," a copy of which, "covering in detail all the routes and information gained during the nine months previous," was forwarded to your office.

I have now the honor to submit to you a condensed and final report, embracing the surveys made in March and April, and all of which give the following results:

It was set forth in the preliminary Report above mentioned that a high spur extended from the Staked Plains eastward, forming the divide between the Brazos and Colorado rivers, and terminating at Comanche Peak, Hood County; that from this spur two secondary ones extended northward—the one crossing the Clear Fork of the Brazos near Fort Griffin—the other crossing the main Brazos near the mouth of Cedar Creek; and that owing to the sinuous course of these streams (Clear Fork and Brazos), and the rough country adjacent, their immediate valleys could not be followed. These topographical features govern the routes, and from the various surveys it is demonstrated that from Fort Worth to the 100th meridian there are three routes from which to select, such selection depending mainly upon the results of the surveys of the Pecos Division. These three routes will be herein designated:

FIRST—The Fort Griffin Route.

SECOND—The Divide Route.

THIRD—The Fort Chadbourne Route.

Previous to the final determination, it is necessary to make the following surveys:

1st. A preliminary location from head of Mary's Creek westward, down into the valley of the Clear Fork—two miles.

2nd. A preliminary location from near Fort Griffin westward, across the spur ridge to the Clear Fork—13 miles.

3rd. A preliminary line from the Leon river westward along the north slope of the Deep Creek Mountains, "the northwest point of which being the difficult point," to the head of Pecan Bayou—36 miles.

4th. A preliminary line from the Leon river westward along

the south slope of the Deep Creek Mountains to near the head of Jim Ned Creek—48 miles.

These surveys are necessary to ensure the correctness of the following data, which are based upon the belief that each will prove the true line upon the respective routes.

It is further assumed, that in the event of the adoption of the "Fort Griffin Route," it will be found to be more advantageous to go via Weatherford than via Silon Creek, which last line is now under progress of survey by Mr. O'Neill, Locating Engineer.

The country has been thoroughly reconnoitered, except near the confluence of Paint Creek and the Clear Fork of Brazos. If it is possible to get out of the valleys of these streams near this point, on a westward course, it may prove the Paint Creek line to be preferable to the more direct route which I have selected—that by the McKenzie's trail, or Steele's branch, being eight miles the shorter.

I do not think that the spur ridge can be crossed elsewhere than in the immediate vicinity of the lines of survey. It rises in elevation for some miles south of McKenzie's trail, more than compensating, probably, for whatever increase of distance, if any, there may be by other creeks south of Steele's branch.

I am of the opinion that no route can be found north of Cedar Creek and Veal Creek, until the one in the vicinity of Fort Richardson, Jacksboro, and Fort Belknap is reached.

From these opinions and from the information gained, it is concluded that

The Fort Griffin Route is the shortest, the best watered, the most contiguous to the best coal fields and the greater body of the best lands. It is the most advantageous in the extension of the Trans-Continental R. R., should the Fort Worth intersection be abandoned. It encounters, however, 3 miles of very expensive work.

The Divide Route is the best timbered, and probably the cheapest per mile; the timber, however, is not of that quality to cause it to be much used for construction, inasmuch as soft timber for bridges and excellent post oak for ties can be brought from the Eastern portion of the State; for fuel, it will be advantageous for operating the road.

The Fort Chadbourne Route is equal in every respect to the Divide Route, except in distance to the 100th meridian, it being six miles longer.

The following table gives the data deduced:

BRAZOS DIVISION.

TABLE OF ROUTES.

	Fort Griffin Route.	Divide Route.	Ft. Chadbourne Route.	Route.
	Miles.	Miles.	Miles.	
Distances	190	198	204	
	Feet.	Feet.	Feet.	
Elevation	3,780	4,000	4,150	
Depression	2,600	2,650	2,685	
GRADES IN FEET, PER MILE.				
	Miles.	Miles.	Miles.	
0 to 16 feet	60.5	65.0	60.0	
16 " 40 "	38.0	45.0	50.0	
40 " 53 "	64.0	65.0	70.0	
53 " 66 "	27.5	23.0	24.0	
Total curvature	4,675	4,160	4,500	
	Feet.	Feet.	Feet.	
Maximum grade	66	66	66	
Maximum curve	6	6	6	

Respectfully submitted,

F. S. HODGES,

Engineer in Charge Surveys, Brazos Division.

GEN. G. M. DODGE,

CHIEF ENGINEER:

DEAR SIR,—In accordance with instructions of January 6th, 1873, I continued the survey westward on the line I was then engaged on, "The Silver Creek Route," going by way of Graham's Salt Works in Young County, and crossing the Brazos

river four and one-half (4½) miles above where the Clear Fork enters it; thence westward by way of the valleys of Fish and Elm Creeks, crossing Double Mountain Fork of the Brazos at St. Mark's old camp; thence by way of Double Mountain to a point ten (10) miles beyond, where we were compelled to stop, as the country to the west was much broken by mountain ridges, and deep lateral gulches and ravines.

From Fort Worth west to the end of our line we met with no serious obstacles. Our maximum grade was 66 feet to the mile, and the sharpest degree of curvature three degrees, or 1,910 feet radius, and an average excavation and embankment of 13,200 cubic yards per mile.

To make the above line feasible, a line would have to be projected from Station 2808 at the head of Parish Creek on the second hundred miles west of Fort Worth, and run in a southwesterly direction to the divide between the Clear and Double Mountain Forks of the Brazos, to a point eighteen (18) miles south of Double Mountain, which would make it about twenty miles longer than by way of Weatherford and Fort Griffin.

After finishing the northern line I returned with the party to Fort Griffin, in the valley of the Clear Fork of the Brazos, and commenced a line about four miles east of that place, at Station 1,866 of the Veal Creek and Fort Griffin route, and run a line westward by way of Trout Creek, crossing the Clear Fork of the Brazos, and following the valley of California Creek, and the divide between Clear and Double Mountain Forks of the Brazos to a point about twenty-two (22) miles west of the 100th meridian, and eighteen (18) miles south of Double Mountain. There we ceased work, as the country beyond is a level plain, and any line from the West will have no difficulty in making a good connection with the line from the East.

The length of the line from Fort Worth to where we left off is 204 miles, viz., by way of the Clear Fork of the Trinity, through Weatherford, crossing the Brazos at McAdam's Bend, or a little above the mouth of Cedar Creek; thence up Veil's Creek and the Clear Fork of the Brazos to Station 1,866 on the line run last March; thence up Trout Creek; thence west to the divide between Clear and Double Mountain Forks of the Brazos.

The last line was run partly by Mr. Hubbard and partly by

myself, and as a portion of the surveys were made last spring, and the notes, &c., sent on to the New York office, I am at present unable to make as satisfactory comparison of the lines as I would wish to do.

The average excavation and embankment on the last line is 17,000 cubic yards per mile, but that amount will be greatly diminished; the maximum grade is 66 feet per mile.

From surveys and a thorough reconnoissance of the country from Fort Worth west, I have come to the conclusion that the best line that can be obtained is up the Clear Fork of the Trinity, to Station 666 of what is known as the Southern line; thence up the south branch of Clear Fork to its head, passing through Weatherford, the county seat of Parker County; thence close to what Hodges designates as the Cedar Creek line to Station 2,576; thence in nearly a due west direction, crossing the Brazos a little above the mouth of Cedar Creek at a place known as McAdam's Bend; thence up Veil's Creek and Clear Fork of the Brazos, on line run by me last March to Station 1,866; thence up Trout Creek to Station 300; from that point nearly a straight line can be obtained to Station 3,036, about twenty-two (22) miles west of the 100th meridian, and eighteen (18) miles south of Double Mountain. This line passes through a fine coal field on the Clear Fork of the Brazos; in places it can be seen cropping out of the bluffs close to the line in thickness of five feet and over. Some the beds have been secured by the Company.

Very respectfully,

Your obedient servant,

JNO. O'NEILL,

DIVISION ENGINEER.

NEW YORK, May 25th, 1872.

E. D. MUHLENBURG, ESQ.,

DIVISION ENGINEER,

Philadelphia, Pa.:

DEAR SIR,—You will proceed to organize parties for the purpose of developing the country from the parallel of longitude 100 and between the 31st and 33rd parallel of latitude. You will proceed to Galveston, and from there to Austin, Waco or San

Antonio, whichever may seem to you the best for fitting out the parties.

Upon your arrival at Galveston, you will arrange with Gen. C. C. Augur, commanding that Department, in regard to the point of meeting the escort which I have arranged to accompany you upon your arrival on the ground.

I desire that a line shall be run from, at or near the S. W. corner of Jones county across the Staked Plains, crossing the Pecos somewhere near the mouth of Deleware Creek; thence through the Guadaloupe Pass westwardly to the Rio Grande, entering the valley of the Rio Grande somewhere between El Paso and Donna Anna. This line is nearly on the extension of our northern line through Texas, and will do for a base to work from, either north or south.

The next line examined I desire shall be farther to the south, say from latitude 31° to 31° 30 minutes on the most practicable route running east, and ending near Fort Chadbourne or south of it as the formation of the country may determine. These two lines will enable you to determine the best line in an engineering and commercial point of view, across the country which you have to examine.

I desire that this country shall be thoroughly developed, so that there can be no doubt as to the line that it is best to locate: the object of your examination is to determine fully before any location is made, the most direct and feasible route, having in view the commercial as well as the engineering value of the line. I want the question so definitely determined that there shall be no doubt about locating the line. If there are any number of lines of nearly equal value, they can all be presented.

Mr. Walcott's line from the Rio Grande west, will start from some point between El Paso and Donna Anna. You will connect with his line on your arrival in the Rio Grande valley. You will also find an office established there by Mr. Walcott, which can be used by both parties. You had better establish headquarters at some point on the eastern end of your Division, where there are regular mail facilities, and where I can reach you at any time.

In outfitting you will have to provide facilities for transport-

ing water for the men, and such animals as you take with you, over a country over 125 miles in extent.

With your main party you want to run a side party under one chief and assistant and two or three men, with horses and a pack train to carry instruments for examining summits. This party can be used in triangulation, exploring the country north and south of the line, and will often determine the work to be done by the party on the main line. It should keep its base with the main line, and run to it as often as the chief of party may require. It will be useful in determining the feasibility of lines that may indicate themselves, and will also enable the main party to advance rapidly and understandingly on the main line, and keep fully posted as to the best routes for the trains and camps.

This party will be useful to you in the triangulation for the purpose of fully developing and mapping the country within the boundaries I have indicated, and also in examining the passes in the different ranges of mountains west of the Rio Pecos.

I lay down for your guidance the following general instructions: For everything purchased receipts must be taken in duplicate, and in your expenditures you must use the strictest economy. You are provided with orders upon the different posts of the U. S. Government, that will enable you to purchase supplies when needed at cost to the Government.

The party must thoroughly arm itself before starting, and your principal assistants in charge of the main and side parties should be engineers of experience, who have good government, understand handling a party; who can grasp intelligently the country and situation, and have courage and energy, and will not run at the first Indian scare.

Your party must be so organized that you can leave it when necessary for you to examine the country; and, above all things, your chief assistants must by their example keep their men at work early and late, so that no time will be lost in the field. You will hold your party to a strict military discipline, and allow no one to be connected with it who is not fully competent to carry out the duties of his position, or who is unwilling to work early and late in the interests of his employers. The party must be well armed when in an Indian country, must never be

off their guard or allowed to straggle, but kept well in hand under protection of the escort.

You must note carefully the water supply, where it is scarce, facilities for obtaining it from springs, sources at a distance or boring; the extent of country that can be irrigated, where located, general condition, &c. One of the party must keep a daily record, noting the weather and everything relating to the surveys, fixing each day so it can be intelligibly referred to hereafter.

I not only want the particular country through which the lines are run developed and mapped, but by a system of triangulations I want the prominent points, streams and mountains fixed accurately as we advance, so that we may fix the basis of a general map, extending over the country we explore, to be filled up in detail by what we observe in our examinations.

The permanent line, when run, should be carefully determined; summits, when of a heavy grade, run to a grade, so as to show the grade, nature and extent of the work to be overcome.

I find that engineers are apt to overlook the necessity of frequent and full reports. They assume it sufficient to see and judge for themselves of the country through which they travel, and therefore neglect to report information, topography, &c., that is often controlling as to location and construction. I want, as far as practicable, what the surveys determine presented for our consideration.

Rough maps, sketches, profiles, &c., to accompany monthly reports, stating briefly what is encountered and what overcome, and the reasons therefor, will be required, when they can be sent without any delay of the party; but as you will be in a country lacking telegraph communication and with poor mail facilities, you will at every opportunity communicate with me, stating briefly where you are, what you are doing, the progress of the party, &c., by letter, in addition to your monthly reports.

In your monthly reports you will present the entire country examined, both by instruments and reconnoissance, so that it can be shown that the capabilities of a railroad in the country have been exhausted. These instructions are general and must be applied as your experience in that country determines. You

will no doubt at times find it necessary to change them, but as a general thing you can comply with them. I enclose orders from the War Department and the Military Division of the Missouri, for escorts from the heads of the different Departments.

For such funds as are necessary to fit out your parties and supply them in the field, you will draw upon Mr. E. B. Hart, Secretary, New York. All vouchers, reports, &c., will be returned to me at such points as I may hereafter designate.

Yours Respectfully,

G. M. DODGE,

CHIEF ENGINEER.

MARSHALL, TEXAS, Oct. 18, 1872.

M. F. HURD, ESQ.,

DIVISION ENGINEER, TEXAS DIVISION:

Dear Sir,—Before this reaches you, you will no doubt have received the telegraphic orders sent to-day; they were general, but probably explicit enough for you to understand what I want.

If you will examine my instructions you will see that the main party should run their line through a country in which we could build a railroad. The side parties were to develop the country north and south, ascertaining if there were better routes. In advance of the main party, but as near as practicable to the general route we would take on that parallel, they were instructed to run from Fort Phantom Hill to the Rio Grande.

Reduce your expenses as much as possible, feed your men well, and see that the side parties have proper escorts. I would do most of my side exploring by triangulations and barometer. Make reconnoitering parties of them as much as possible.

So far as I have seen the profile, you appear to have a good line to the north; probably Muhlenburgh has one equally as good in the vicinity, but I am unable to judge.

The line further south, over which you return, should be very carefully examined. No doubt in going through to the north you will exhaust that country and know exactly what can

be done there. As you strike east from El Paso you will run towards Fort Chadbourne, getting the best ground along that parallel.

I requested Gen. Augur to send the commander of the escort a letter of instructions by the messenger to aid you all he could in helping you through.

MARSHALL, Dec. 5, 1872.

I do not want to go south of the 31st parallel: what I want is to have that southern country fully developed, so we may know exactly the best line through it. I also want the country thoroughly examined from Mesilla, directly east. The map shows that the line directly west from Sulphur Springs would about strike Mesilla, and would cross the Pecos in the vicinity of the Rio Penasco or north of it.

I should think that a pack party traveling up through that country, would determine whether there were any routes north of your main line.

MARSHALL, Jan. 3rd, 1873.

I have written Mr. Walcott to consult with you about explorations east of the Rio Grande and north of the Deleware Creek line.

I am anxious about that country, and want you to confer fully with him and get him to travel over it with you if possible: although it is out of his Division, still I would like the opinion of both of you upon it.

The hard country that we shall meet east of the Sierra Nevada is that portion of your line between the Pecos and the Rio Grande: it will have to be explored until there is nothing in it you have not seen.

MARSHALL, Jan. 12th, 1873.

I am somewhat disappointed in your report of the line through Guadaloupe Pass.

Your report upon that route makes it more important to follow out my instructions sent herewith, to develop the country between the Pecos and Rio Grande, and I hope you will find something north or south far better.

The crossing of that country is the heavy work between here and the Sierra Nevada, and we must give it close attention.

* * * * * * * * * *

What I want first, without countermanding any instructions heretofore given, is to develop the country between the Pecos and Rio Grande, and fix a line that we will have to locate upon.

Everything east and west of the Guadaloupe range is dependent upon the crossing of it.

As I wrote you, I would like to have Walcott examine it with you. Keep your party at work upon the different lines crossing that range from the extreme north to the extreme south, until you have thoroughly developed that country and can tell me definitely what line we should adopt.

MARSHALL, Oct. 1st, 1873.

I am sorry that the north line turns out badly. I hope your south line will be better. After turning the Guadaloupe, you should, if the country is favorable, make direct for Double Mountain, or in that direction, so as to give as short a distance as possible from the connection with O'Neill to the Pecos.

I cannot judge intelligently from here, but it seems to me if you get the return line you expect, you will have a shorter line from O'Neill's to El Paso than by any other route.

Oct. 9, 1873.

If you get this before running your line east of the Rio Pecos, I desire you to move with your party to the mouth of the Hondo, and examine that route or some route near it through to the Rio Grande. If it is feasible, we want to make a connection with Walcott's line as direct as possible.

Probably you will have to run down the valley east of the Sierra Solidad range. It, however, may be possible to find a feasible crossing of the range, crossing the Rio Grande far north of where Walcott's line leaves the valley. If this line would be found feasible we could make our connection east with O'Neill at some point on the Brazos, passing north of "Double Mountain," perhaps north of "Mount Cooper." The feasibility of this route can be ascertained by you without running a line. If you have passed the Pecos and are well on your way to a connection with O'Neill before receiving this, it is more economical to make that connection. After it is made, remove to the mouth of the Hondo, making a reconnoissance as you cross the Staked Plains. Make the examination between the Rio Pecos

and the Rio Grande as above directed, if you get this letter in time.

It is probable that you could determine the feasibility of the Hondo route while your lines are being run the southern route, and not be forced to take the party north unless the examinations prove the line to be feasible.

I am, respectfully,
G. M. DODGE,
CHIEF ENGINEER.

MARSHALL, TEXAS, FEB. 11, 1874.

GEN. G. M. DODGE,
CHIEF ENGINEER, T. & P. RAILWAY:

DEAR SIR,—I have the honor to report to you the results of the surveys from the 100th meridian to the Rio Grande. Time of surveys, from July, 1872, to January, 1874. The lines will be designated as follows:

1. The Center and North lines, from Fort Phantom Hill to Sulphur Springs.
2. The Center line, from the Sulphur Springs to the Rio Pecos.
3. The Delaware Creek line, from Rio Pecos to Fort Bliss, *via* the Guadaloupe Pass.
4. The South line, from Fort Bliss to Fort Chadbourne, *via* Cariso Pass and head of main Concho River.
5. The Toyah Creek and Big Spring line.
6. The Salt Lake and Sulphur Spring line, the latter connecting with the North line at the Springs.

In addition to these lines, *reconnoissances* were made through the Organ, Sacramento and Northern Guadaloupe Mountains, and from Fort Stockton to Fort Seldon, *via* the Rio Hondo, Fort Stanton and Fort McRae.

In July, 1872, three parties were organized in Austin, Texas, by E. D. Muhlenburgh, Division Engineer, Mr. Zan Cetti, J. Barrett and myself being chiefs of parties. We reached Fort Concho on July 25, 1872, when it was decided to make Fort Phantom Hill (latitude 32° 31′, longitude 99° 45′) the initial point. We started three lines on August 10, 1872: the Center line, under the immediate charge of Maj. Muhlenburgh;

the North line, with its initial point 18 miles north of Phantom Hill, and to be parallel with the Center line; and the South line, under charge of Mr. J. Barrett. As the South line was abandoned, and the party disbanded soon after the commencement of the work, the Center and North lines only will be considered in this report.

THE NORTH LINE.

As subsequent surveys of the Brazos Division have made a connection with the North line, south of Double Mountains, I will only give a general description of the first 42 miles.

The country is rolling and well watered by the numerous tributaries of Elm Fork of Brazos River. The timber on the first ten miles is a scrubby growth of post oak, and will furnish only a small quantity of ties; from this on there is no timber, but a small growth of mesquite, valuable only for fuel. I was informed that north and west of Double Mountains the mesquite grew large enough for ties. For durability the mesquite is equal to cedar. The soil is a sandy loam, very fertile, not requiring irrigation, with limestone of an excellent quality in abundance.

From the 42d mile, or connection with the Brazos Division, to Sulphur Springs at the eastern edge of the Staked Plains, a distance of 85 miles, the line as run is practicable, the maximum grade being 76 feet per mile; but much lighter work and grades not exceeding 52 feet per mile can be obtained by running about 3 miles further north, until reaching the divide between Elm Fork of the Brazos River and the Colorado River, crossing it about a mile below the present crossing, and avoiding the north fork of the Colorado and the heavy rock cutting between the two streams, also the bluffs on the west side of the Red Fork, and lessening the bridging at least one half over the main stream.

The first 10 miles west of the river are along the edge of the bluffs, and is heavy sand rock cutting, but that will be avoided by the proposed location below the junction of the streams, giving light work. From where it will connect with the present line, about ten miles west of the river, to Sulphur Springs, a very slight change from the preliminary line will be necessary.

The soil west of the river is more sandy and less fertile than that on the east; still I think most of it can be made productive. The high mesquite gradually grows smaller until it entirely disappears at the Staked Plains, the scrub mesquite taking its place, of which the roots only can be used for fuel.

The North line was dropped at Sulphur Springs; but as it now forms a part of the Salt Lake and Sulphur Springs line, the estimates will be considered in connection with those of that line.

The Center line being abandoned from its initial point to the Staked Plains, a detailed description will be unnecessary. It follows the valley of the Elm Fork of the Brazos River about 40 miles: the general features are similar to the North line, only somewhat more broken, with a greater area of bottom lands. After leaving Elm Fork it gradually approaches the North line; and from the Colorado River west, there is no real difference in the topographical features of the line. The length of the Center line from its initial point to Sulphur Springs is 133 miles; of the North line, 127 miles.

The Center line from Sulphur Springs was run under the immediate charge of E. D. Muhlenburgh. Crossing the Pecos River 30 miles below the mouth of Delaware Creek at Sulphur Springs, we commence at once to ascend to the Staked Plains, a mesa elevated about 500 feet above the country east and west of it, the grade for the first 4 miles being 66 minutes per mile; from thence to the summit, about 40 miles, we have easy grades and light work, the descent towards the Pecos River being nearly the same as the ascent from the east.

The plains are entirely destitute of timber above ground, but plenty of mesquite roots can be obtained by digging; the grazing is excellent, and the soil is gravelly, underlaid with limestone. No water was found on the plains between the eastern edge and the white sand hills, which are situated at the foot of the western slope of the plains, about 75 miles from water on the east side, and 40 miles from the Pecos River. They extend from latitude 31° to 34° 30′ and run parallel with the Pecos valley, averaging about 3 miles in width, with frequent breaks in the range, where the red sand takes the place of the white, where the hills are lower and the sand does not shift, enabling

us to obtain a good line through them. Plenty of water can be obtained at the foot of the sand hills by digging from 1 to 3 feet, and it is undoubtedly rain water held by a substratum of clay.

From this point to the Pecos River the soil is sandy and the grades and work very light. The line reached the Pecos on the 1st day of November, 1872, and on the 6th I received instructions from you to take charge of the party, and since then I have had supervision of the surveys.

The Center line was continued west from the Pecos, with the intention of crossing the Guadaloupe range south of the Piney but the foot hills forced the line north, and a connection was made with the Delaware Creek line about 60 miles from the Pecos River. After leaving the valley, which is about ten miles wide, the line passes through a broken country. The soil of the valley is largely mixed with alkali; the hills are of limestone and gypsum; a salt spring about 25 miles from the river may be of considerable value; there is no timber, and the grass generally is good. The line was abandoned.

The Delaware Creek line commences at the mouth of the stream, $2\frac{1}{2}$ miles north of the Texas and New Mexico boundary line; it follows the valley in a southwesterly direction to what is generally known as its head, 35 miles from the Pecos River. The alignment is good, the grades easy and the work not heavy. The valley has an average width of $1\frac{1}{2}$ miles, is fertile, and can be irrigated at a small expense, there being plenty of water in the creek for that purpose. The creek runs for the last 16 miles through an extensive deposit of gray and crystalized gypsum. From this point the line follows the southern drainage of the creek for 15 miles, and 5 miles south of Independence Springs, the maximum grade being 80 feet to the mile; from here to the summit the ascent was so great that a direct line was impossible,—consequently the line was swung south, keeping the sides of the foot hills, and the main range was reached 4 miles south of the Piney; from thence the eastern side of the range was kept to the summit, with a maximum grade for 7 miles of 116 feet per mile, with very heavy work.

From the summit the line bears northerly, keeping the sides of the high peaks of the Guadaloupe Mountains, with a constant

grade of 90 feet for 21 miles. The first 12 miles is a succession of mountain spurs, their sides frequently so precipitous that it was extremely difficult to lay a line on them, and the curvature very sharp. The surface of the mountain is very little broken, and no difficulty was found in laying very near a surface line from this point to Crow Springs, a distance of 4 miles. The line crosses several salt lagoons, ascends to a mesa near the Springs, passing north of Cornudas and Los Alamos, follows the eastern base of the Huecca Mountains for about 15 miles, and passes into the valley of the Rio Grande with grades for short distances of 100 feet per mile.

After leaving Crow Springs, the only waters on this line are the natural tanks at Cornudas and Los Alimos Springs: the latter are sometimes dry. The soil is gravelly on the mesa, and limestone on the ridges, and would probably be of no use except for grazing.

As the line from the western base of the Huecca Mountains to Fort Bliss forms a portion of the Salt Lake and Sulphur Springs line, a full description will be given of it in connection with that line. As it is not at all likely these lines will be adopted, I will only give an average estimate of cost from Phantom Hill to Fort Bliss.

	Miles.	Total Cost. $ c.	Cost per Mile. $ c.
1. North Line, Phantom Hill to Staked Plains	127	4,343,142.00	34,198.00
2. Center Line, Staked Plains to Rio Pecos.....	117	2,455,316.00	20,985.60
4. Delaware Creek Line, Intersection to Crow Springs.....	30	9,914,162.00	319,811.67
5. Center Line, Pecos River to Junction with Delaware Creek Line.....	59	3,347,210.00	56,732.37
6. Delaware Creek Line, Crow Springs to Ft. Bliss	118	4,603,472.00	39,012.47
Total...	452	24,663,302.00	54,564.82

The cost of the Center Line from Phantom Hill to Sulphur Springs, distance 133 miles, will average about the same as the Northern Line.

During January and February, 1873, I made two *reconnoissances* north of Fort Bliss, between the Rio Grande and the Pecos, in hopes of finding a more practicable line, either through the Sacramento Mountains, or the southern base of that

range, and the north end of the Guadaloupe Mountains. My first examination was up the western side of the Organ Mountains, crossing that range through Solidad Pass, forty miles from Fort Bliss and eighteen miles southeast of La Messilla. The pass is about eight miles wide. The descent on the east is 52.8 feet per mile, and I persume about the same can be obtained on the west, with very few inequalities of surface.

From there I followed up the eastern base of the range, examining San Augustine and San Nicholas Passes. The former is twenty-seven miles from Solidad Pass, and the latter forty-five miles, and neither of them is practicable. There is no timber of any consequence, but plenty of water in the mountains, and, like most of the streams in that country, they do not flow any distance from the cañons. From San Nicholas Pass I crossed the Solidad Plains in an easterly direction to Alamo Cañon, in the Sacramento Mountains, a distance of thirty-five miles. The plains are quite sandy, and eighteen miles from San Nicholas are white water springs or holes, in which the water is found two or three feet below the surface, at the base of the gypsum banks, which is a singular formation of pulverized gypsum thirty miles long and twelve miles wide. The water is very brackish. At the north end of the banks there are some small salt lakes. I found no possible chance of getting through the mountains by way of Alamo Cañon, as it terminates against the highest peak of the range. I followed down the range to the south end forty-one miles, finding it totally impossible to get a line through them. At this point the main range bears nearly due east, connecting, however, with the Huecca Mountains on a mesa, the lowest point of which was at the base of the main range. From the mesa I could see, as I supposed, a plain extending past the Guadaloupe Mountains. I returned to Fort Bliss *via* the Huecca Mountain tanks, and in a few days after, in company with Col. Walcott, started from Solidad Pass. Ascending the mesa at the south base of the Sacramento Mountains, we followed a beautiful valley for twenty-five miles, when we encountered a high spur of the Sacramento Mountains, which terminates in the table land at Crow Springs. We crossed this about twenty miles south, with heavy grades and work. Subsequent examination has proven that there is no practicable pass

between this and the main range. Crossing this, in about eighteen miles we passed into the Salt Plains, which we followed up to the north end of the Guadaloupe Mountains.

The Guadaloupe Mountains are a part of the Sacramento Range, being connected by three spurs, the lowest of which Col. Wolcott and I examined and pronounced totally impracticable, with no possibility of getting through the range between that point and Guadaloupe Pass.

The return lines from Fort Bliss to Fort Chadbourne consist of the South Line *via* Carisso Pass, north end of Castle Mountains and head of main Concho River, in charge of Mr. Zane Cetti. The Toyah Creek and Big Spring Line commences at the crossing of the South Line at Toyah Creek, and following that stream to its mouth, crosses the Staked Plains *via* Mustang Springs, head of North Concho River, Big Springs and Oak Creek; Mr. R. J. Moscrip in charge.

The third party, in charge of Mr. C. Chesbrough, re-examined the Delaware Creek Line from Crow Springs to the head of the Delaware, joining the second party at the mouth of Toyah Creek, from which point the two parties worked together.

The South Line commences on the Delaware Creek Line about eleven miles east of Fort Bliss, and follows down the valley of the Rio Grande for thirty miles, then bears eastwardly, crossing the table land of Eagle Mountians through Carisso Pass about thirty-five miles north of Fort Quitman and sixty-eight miles from Fort Bliss. After leaving the valley, the country is broken and rough and the work heavy.

Through the Carisso Mountains a tunnel 6,000 feet long is necessary, with a grade of 116 feet per mile. The line crosses the spur of the Davis Mountains at the base of Picacho Gomez, and from thence descends into the valley of Toyah Creek. From Toyah Creek to the Pecos River, and across the Staked Plains to the head of main Concho River, the country is so similar to the other lines that a description of it would only be a needless repetition.

From the Concho River to Fort Chadbourne the line is generally on the bluffs of the Concho and Colorado Rivers, and requires three tunnels of an aggregate length of 10,600 feet, and gradients of 116 feet per mile. The length of the line is 369 miles, and there is no timber of any consequence on the line.

ESTIMATE OF COST.

Total length of line estimated 369 miles.

Cost, - - - - -	$14,679,056.00
Cost per mile, - - -	$39,997.43

The Toyah Creek Line should be in connection with the South Line, as it is identical with it from Toyah Creek to Fort Bliss, and was run to develop the country between North Concho and Colorado Rivers. There is no marked difference in the country between this and the center lines across the Staked Plains. From Mustang Springs, at the head of North Concho River, the high bluffs of the North Concho forced the line into the valley of the south branch of the Colorado River, which was followed to its junction with the main stream ; thence due east to the head of Oak Creek, following that stream to Fort Chadbourne. The line in the plains is from twenty-five to thirty-five miles south of the North Line. The country is now broken and rocky, with plenty of water. The timber is a scattering mesquite except on Oak Creek, on which stream and its tributaries 40,000 ties probably could be procured. Forty or fifty miles of side lines were run south of this; but nothing of importance was developed. The several lines to Fort Chadbourne were completed May 14, 1873, and the total number of miles of instrumental lines run up to this time was 1,117.

I went into Fort Concho May 26, 1873, and in accordance with instructions received from you at that time I organized one party, under charge of R. J. Moscrip, principal assistant, to make further examinations in the Guadaloupe Mountains.

In July and August the range was thoroughly examined on the eastern side from a point forty miles south of Guadaloupe Pass to the north end of the range, finding no practicable or even possible route. I had thought a good line might be found by following up the Rio Penasco, and taking the eastern slope of the Sacramento Mountains, crossing the spurs connecting the Guadaloupe Mountains near the base of the main range, and taking the southern slope into the valley of the Solidad, reach- the Rio Grande *via* Solidad Pass. Accordingly, before joining the party in August, I went from Cornudas Mountain to the

head of the Rio Penasco, and found those spurs more difficult than the main range. It was desirable to get a north line on account of the timber which covers the entire range of the Sacramento Mountains; but I was compelled to give it up. I then followed down the western base of the Guadaloupe Range to a point about fifty miles south of Guadaloupe Springs, and was satisfied that there would be no difficulty in getting a satisfactory line over the mountains.

THE HONDO RECONNAISSANCE.

November 4, 1873, I received a communication from you instructing me to examine the country between the Pecos and Rio Grande *via* the Rio Hondo. Accordingly, while the line was in progress across the plains, I went up the Pecos River to the Hondo, distant from Delaware Creek 100 miles.

From the best information I could obtain, there is but little difference in the topographical features of the country between the Hondo and the Cooper Mountain, and the lines run below. The distance across the plains is about 45 miles more than from Delaware Creek to Sulphur Springs.

The valley of the Hondo, for the first forty miles up it, is about three miles wide, and the ascent easy. The creek is a bold, rapid stream, furnishing water enough, ordinarily, to irrigate the entire valley from the source to its mouth. There are settlements about every three miles for the entire distance. From this point to the Junction, Rio Ruidoso and Rio Bonita, thirty-one miles, the creek is very crooked, frequently cañoning for short distances, then forming valleys about a mile wide. The line would neccessarily cut the points, giving heavy rock cuttings and an ascent of about seventy feet per mile. The last ten miles was through the foot hills of Capitan Mountains. From the Junction to Dowling's Mill, near the head of the Ruidoso, twenty-seven miles, the ascent is about seventy-five feet per mile, and the country more rugged. The mountains are thickly covered with cedar for the first fifteen miles: from there a dense forest of pine takes its place. The pinery is about fifty miles long and twenty-five miles wide, Alamo Cañon being in about the center, north and south.

From Dowling's Mill to the summit of Tulerosa Pass, about eleven and five-tenths miles, the ascent is about ninety feet per

mile to within two miles of the summit, when it increases to 150 feet per mile. From there to Blazer's Mill, a distance of eight miles, the descent is at least 175 feet per mile. A maximum grade of 116 feet would require a tunnel two and a half miles long. From the mill to the town of Tulerosa, a distance of of eighteen miles, the valley is watered by Tulerosa Creek, and is well settled. There are two saw mills in the cañon.

From Tulerosa to Solidad Pass summit the distance is sixty-four miles.

From the mouth of the Rio Bonita to Fort Stanton, a distance of twenty-two miles, the valley is very similar to the Ruidoso; the ascent, perhaps, a little less. The only possible outlet from Fort Stanton is northwest, between the Capitan and White Mountains. The ascent to the Nogal Mountains, "a spur of the White Mountains connecting them with the Capitan Mountains," a distance of fourteen miles, following up a branch of the Rio Bonito, is about 116 feet per mile; but the descent into the Solidad Valley is 1,000 feet in a distance of three and one-half miles, and not feasible to take the slopes of either White or Capitan Ranges, as they are fully as rugged as the Guadaloupe Mountains.

From here to Fort McRae the principal features are the Solidad Plains, forty-five miles in width, with springs of pure water every fifteen miles.

Through McRae Pass, in the Organ Mountains, a distance of twenty-five miles, the ascent and descent is about 120 feet to the mile. The surface is very broken, and the range covered with a thin growth of scrubby cedar.

The Laguna del Muerto, a plain between the Organ and McRae Mountains, eighteen miles southeast of Fort Craig, has very brackish water on its eastern borders.

If a good line could be obtained through the White Mountains, it would either have to follow down the plains to Solidad Pass, or, if going through McRae Pass, would cross Laguna del Muerto to Fort Seldon or near there. Crossing the river at Fort McRae would involve heavy work, and grades of ninety feet per mile for twelve miles east, and full as great a distance west from the river, and thence bearing south, would connect with Wolcott's line in the vicinity of Fort Cummins.

The timber in the Sacramento Mountains, and the *coal* in the vicinity of Forts Stanton and McRae, might be a sufficient inducement to make a thorough instrumental survey through them.

The McRae Mountains extend from near Fort Craig to Fort Seldon. The crossing of the river is equally good at McRae and Seldon. Water is more plentiful on the western slopes of the mountains on this line than on the south lines. The accompanying map will give a better idea in detail of the country.

I had designed to return to the Hondo and examine the country from that point east *via* the head of the north fork of the Colorado River, and go into Fort Griffin some twenty-five miles north of Double Mountains. The impossibility of getting the necessary transportation for crossing the plains ended the *reconnaissances* at Fort Seldon.

THE SALT LAKE & SULPHUR SPRINGS LINE.

The first thirty-four miles of this line, east of Fort Bliss, is common with the Delaware Creek Line. At this point commences the ascent of the Huecca Mountains, the summit of which is reached in ten miles, with maximum gradients of 100 feet. The alignment is good and the work light. From the summit, for a distance of fifteen miles, the plains are somewhat broken, with a descent same as ascent. The line then bears southerly towards the Black Mountains, descending into the valley of the Salt Lakes near the north point of Sierra Diablo, and five miles south of Salt Lake, the distance from the summit of Huecca Mountains to the valley being forty-six and one-half miles. The line is over a high table-land, or, more properly, a pass of about thirty miles width, between the Wind Mountains and the Sierra Prieto, the Huecca Mountains being the western and the Diablo Mountains the eastern boundaries of the mesa. The plain is entirely destitute of timber, and the rock principally limestone, with an occasional outcropping of granite.

The nearest water to this line is Los Alimos Springs, twenty-five miles north of the center of the mesa. The soil is gravel, and of no particular value for agricultural purposes. The descent into the Salt Lake is very easy, with no gradients ex-

ceeding fifty-two and eight-tenths feet per mile. From this point the line crosses the valley diagonally, passing about a mile south of the southern point of the Guadaloupe Mountains, and crossing the divide near its connection with the northern spurs of Davis Mountains. The heavy ascent to the summit is in the last three miles; maximum, 100 feet. The distance across the valley is forty-two miles. The principal characteristics of the Salt Lake Valley are the Salt Lakes, extending over a distance, north and south, of about 100 miles, and the numerous springs extending over the same country as the lakes. The waters of the springs are not much more brackish than that of the Pecos river.

There are also a number of springs in the Diablo Mountains, which can easily be made available for the use of the road. Only a portion of the valley can be cultivated. The Salt Lakes will be of great value to the Company, as the settlements on the Rio Grande and in the interior of Mexico, as far as the city of Chihuahua, are now supplied with salt entirely from these plains.

The descent from the summit into the valley of the South Saladilo is rapid; but location will reduce the grade to eighty feet per mile, without increasing the work. From here the line follows the valley, "which has hardly any obstruction in it," to the Pecos River, which it crosses fifteen miles above the Toyah Creek Line, and fifty-four miles below Delaware Creek. No water was found in the vicinity of the line between the summit and Pecos River. From the Pecos to the connection with the North Line at Sulphur Springs, the line is direct, and does not vary in its features from the other lines crossing the Staked Plains already described; the distance from Fort Bliss to Sulphur Springs being 310.6 miles, and fifteen and one-half miles shorter than that by the Guadaloupe Pass.

Total number of miles of instrumental lines run, 1,675, and 1,200 miles of *reconnaissances.*

The country developed, lying between longitude ninety-nine degrees forty-five minutes and the Rio Grande, 460 miles, and from latitude thirty degrees thirty minutes to latitude thirty-four degrees.

TABLE OF GRADES.—SALT LAKE AND SULPHUR SPRINGS LINE.

SECTION No. 1.	Ascending.	Descending.
Between 0 and 20 feet per mile.....	9.20 miles.	10.42 miles.
" 20 " 40 " "	13.03 "	4.73 "
" 40 " 60 " "	14.35 "	14.09 "
" 60 " 80 " "	4.56 "	
" 80 " 100 " "	.85 "	
" 100 " 116 " "		
Level Grade....	.....	13.77 "
	85 miles.	

SECTION No. 2.	Ascending.	Descending.
Between 0 and 20 feet per mile.....	32.19 miles.	31.53 miles.
" 20 " 40 " "	6.15 "	6.81 "
" 40 " 60 " "	9.28 "	10.32 "
" 60 " 80 " "	.75 "	1.70 "
" 80 " 100 " "	1.13 "	
" 100 " 116 " "		
Level Grade....	.....	15.09 "
	115 miles.	

SECTION No. 3.	Ascending.	Descending.
Between 0 and 20 feet per mile.....	.06 miles.	3.21 miles.
" 20 " 40 " "	18.93 "	6.62 "
" 40 " 60 " "	11.36 "	9.66 "
" 60 " 80 " "	2.65 "	.18 "
" 80 " 100 " "	3.03 "	1.13 "
" 100 " 116 " "	.56 "	.75 "
Level Grade....		6.89 "
	87 miles.	

SECTION No. 4.	Ascending.	Descending.
Between 0 and 20 feet per mile.....	10.51 miles.	14.31 miles.
" 20 " 40 " "	20.55 "	6.83 "
" 40 " 60 " "	15.83 "	8.57 "
" 60 " 80 " "	.....	5.84 "
" 80 " 100 " "	3.54 "	5.20 "
" 100 " 116 " "		
Level Grade....	.....	17.50 "
	1,085 miles.	

ESTIMATE OF COST.—0 TO SULPHUR SPRINGS.

SECTION No. 1.—DISTANCE, 95 MILES.

1,796,200	C. Yards Earth Excavation, at.....	$ 28	$502,936 00
335,000	" " Rock " ".....	1 60	536,000 00
1,400	" " Masonry " ".....	8 00	11,200 00
2,330,000	Feet B. M. Timber, ".....	35 00	81,550 00
5,000	Lin. Feet Piling, ".....	75	3,750 00
250	" " Howe Truss, ".....	45 00	11,250 00
265,000	Cross Ties.	50	132,500 00
9,995	Tons Iron.....	95 00	949,525 00
	Station Buildings.....	.....	30,000 00
	Wells and Tanks.....	.....	35,000 00
	Tracklaying.....	.....	100,000 00
	Total.....		$2,393,711 00

ESTIMATE OF COST.—0 TO SULPHUR SPRINGS.

(Continued.)

SECTION No. 2.—100 MILES.

1,273,400	C. Yards Earth Excavation, at.....	$ 30	$382,020 00
96,000	" " Rock " ".....	1 70	163,200 00
62,000	Feet B. M. Timber, ".....	45 00	2,790 00
	Clearing and Grubbing.....	.....	2,300 00
278,250	Cross Ties, at.....	60	166,950 00
10,500	Tons Iron, ".....	100 00	1,050,000 00
	Station Buildings.....	.....	30,000 00
	Wells and Tanks..	.....	45,000 00
	Tracklaying.....	.....	105,000 00
	Total.....		$1,947,260 00

SECTION No. 3.—100 MILES.

905,700	C. Yards Earth Excavation, at.....	$ 30	$271,710 00
91,000	" " Rock " ".....	1 70	154,700 00
240	" " Masonry " ".....	10 00	2,400 00
67,000	Feet B. M. Timber, ".....	65 00	4,355 00
600	Lin. Feet Piling, ".....	80	480 00
125	" " Howe Truss, ".....	45 00	5,625 00
	Clearing and Grubbing, ".....	.....	2,300 00
278,250	Cross Ties, ".....	65	180,862 00
10,500	Tons Iron, ".....	105 00	1,102,500 00
	Station Buildings.....	.....	30,000 00
	Wells and Tanks.....	.....	45,000 00
	Tracklaying.....	.....	105,000 00
	Total		$1,904,932 00

SECTION No. 4.—100 MILES.

1,473,800	C. Yards Earth Excavation, at.....	$ 30	$442,140 00
230,000	" " Rock, " ".....	1 70	391,000 00
200	" " Masonry, ".....	6 00	1,200 00
79,000	Feet B. M. Timber, ".....	70 00	5,530 00
278,250	Cross Ties, ".....	70	194,776 00
10,500	Tons Iron, ".....	110 00	1,155,000 00
	Station Buildings.....	.....	30,000 00
	Wells and Tanks.....	.....	35,000 00
	Tracklaying	.....	105,000 00
	Total.....		$2,359,846 00

Total.....$8,605,549 00

Length of Division.....395 Miles.....$21,786 31 per Mile.

The examinations have been thorough, and there can be no question as to which line should be adopted. From the connection with the Brazos Divisions, eighteen miles south of Double and Flat Top Mountains, bearing southerly to Sulphur Springs, crossing the Pecos River fifty miles below the mouth of Delaware Creek and the Guadaloupe Mountains by the pass known as Hurd's Summit, leaving the Salt Plains within a half mile of the north end of Sierra Diablo, following the Sierra Prieto for about fifteen miles, and leaving the Huecca Mountains through a low pass twenty-two miles south of Sierra Alto, of the Huecca Range, and from thence taking the second valley of the Rio Grande directly to Fort Bliss.

By going from the western base of the Huecca Mountains directly to Solidad Pass, "the line being on the same plain as Fort Bliss," and connecting with the New Mexico Division near La Mesilla, the line could be considerably shortened, avoiding the fifteen miles of heavy work on the present line between Fort Bliss and Scott's Ranche; also bringing the timber of the Sacramento Mountains twenty miles nearer the road.

There will be no really heavy work on any part of this line, and the maximum grade will be reduced to eighty feet per mile on location, without any increase of work, and very little increase of curvature. The maximum curvature will not exceed six degrees, or a radius of 1,146 feet.

Between Sulphur Springs and the Rio Grande there can be four tangents, from thirty to forty-five miles long, and the cost of the road will be at least $9,000 less per mile than the cheapest of the other lines run. In addition, it will take eighteen months less time to build the road on this line.

A more definite reference to the material necessary for the construction of the road and the resources of the country along the Salt Lake Line may be desirable.

STONE.

Stone of excellent quality, "suitable for every variety of work where stone can be used," is everywhere found immediately on the line, except in the basin between the Sand Hills and the Pecos River, where it will be necessary to haul it from eight to ten miles, and in the Salt Plains, where five miles would be the extent of haul. It is principally limestone.

TIMBER.

There is no timber suitable for bridging or ties on the line. The nearest that can be made available is in the Davis Mountains. Twenty-eight miles from the line, at a point twenty miles east from the Guadaloupe Range, there is a large body of pine more than sufficient to bridge and tie the road from there to Fort Bliss. A great many cedar ties can also be obtained there. The mountains are very rugged, and the getting of timber from the cañons to the plains would be attended with some difficulty. From the base of the mountains to the line there is an excellent natural road. If Mexican labor is used, the expense of delivering the ties will not be very great. The timber in the Guadaloupe Pass can be reached from the western side of the Salt Plains in a distance of thirty miles. Probably 200,000 cross-ties could be obtained, and considerable bridge timber, with no serious difficulty in getting it out of the mountains.

In the Sacramento Mountains timber can be reached from the line in the valley of the Rio Grande, about thirty-five miles from Fort Bliss, in a distance of fifty miles *via* Solidad Pass. It would undoubtedly be practicable to get timber from there by teams; but a narrow-guage road could be built to the timber with very little expense of grading, and no bridging. I think ties could be delivered on the line cheaper by this means than by transporting them from the East. There is a small quantity of timber in the Organ Range, but hardly worth the trouble of looking after.

WATER.

From the eastern edge of the Staked Plains to the Rio Grande, the only running stream crossed on the line is the Rio Pecos. On the Staked Plains no springs were discovered, yet I am perfectly well satisfied that abundance of water can be found anywhere on them by digging to a depth not exceeding 150 feet, and, probably, within seventy-five feet. All of the streams running easterly through Texas head in the plains, the sources of the larger ones being found from ten to twenty miles on the plains. In the Sand Hills there will always be found plenty of water.

West of the Pecos, I think, water can be found at about the same depths as on the plains. In the Guadaloupe Mountains reservoirs can be very easily constructed that will furnish a sufficient supply. In the Salt Plains the springs of the Sierra Diablo can be brought to the line in a distance of from three to seven miles.

On the Mesa, from the Salt Valley to the Rio Grande, reservoirs would be the most economical, and answer equally as well as wells.

COAL.

The only evidence of coal (and that by no means positive) I have seen, is near the base of the Guadaloupe Mountains, about eight miles north of the Deleware Creek Line. If there is any there I think it lies very deep. A more thorough geological examination will be required to determine the mineral value of that country.

There is iron through all the ranges of mountains, especially in the Organ, Huecca and White Mountains. Gold and silver are now being taken out of the Organ and White Mountains. There are several causes which have prevented the development of the precious metals in that region, the principal one being, that the Indians guarding the old Spanish mines have killed several parties who attempted to re-open them, and that endless Mexican claims are produced as soon as a mine is opened and becomes productive.

AGRICULTURE.

Nearly all the country east of the Plains is susceptible of cultivation, and ordinarily there is plenty of rain. The Staked Plains are admirably adapted to grazing, there being only an average of 75 miles between water, and I have no doubt that a more thorough examination will develop many springs now unknown. Besides, as I have already remarked, the expense of sinking wells will not be very great, or, what would be cheaper and better, reservoirs could be constructed.

The Pecos Valley, although not as extensive as the Rio Grande, I think is fully equal to it in every other respect, and

probably better for fruit; while between it and the Guadaloupe Range there can be no better country for stock, and it is admirably adapted to sheep raising.

Besides this, in the Valleys of Toyah and Deleware Creeks, Rio Azoul, Seven Rivers and Rio Penasco there is an average area of each that can be cultivated of about fifty-five miles in length by four miles in width. The Salt Plains are principally valuable for salt.

For the geology and mineralogy of the country, I refer you to the report of Mr. W. P. Jenny, geologist of the expedition.

In conclusion, I wish to express my appreciation of the valuable assistance received from R. J. Moscrip, Esq., Principal Assistant, whose energy, industry and judgment contributed largely to the success of the survey; also to Assistant W. L. Alexander, for the accuracy of his work, and the constant cheerfulness with which he performed his duties.

Respectfully submitted,

M. F. HURD,

DIVISION ENGINEER.

COUNCIL BLUFFS, May 12th, 1872.

GEO. WOLCOTT, ESQ.,

DIVISION ENGINEER, TEXAS AND PACIFIC RAILWAY:

DEAR SIR,—You will proceed to organize parties for the purpose of developing the country from the Rio Grande to the Pima Villages, just below the mouth of the San Pedro, and north of the southern boundary of the United States, and south of the Gila River.

The line demonstrated by the limited *reconnaissance* made up to this time as the best, leaves the Rio Grande north of El Paso, near La Mesilla, going directly to the Valley of the Rio Miembres, then passing the Peloncillo Summit south of the Sugar Loaf, thence to the Valley of San Domingo.

Passing west, you encounter the Chiricahua Range on the south, and Pinalen on the northwest—the most difficult of all the ranges to overcome. The pass through these mountains, known as Railroad Pass, just south of Mount Graham, is said to be the easiest of ascent and lowest in the range. Passing through this pass and along the southwest slope of Mount

Graham, following the Arivaypa Cañon to the San Pedro, and then to the Gila, and down it to the open country.

The maps given you will show the routes examined by Emory, Parks, Cook, Gray, Potter and myself. I passed over the route followed by Parks, and am convinced that by a thorough examination of the country, a feasible, direct and cheap line can be obtained, with low grades. The object of your examination is to determine fully, before any location is made, the most direct and feasible route, having in view the commercial as well as engineering value of the route.

I want the question so definitely determined that there shall be no doubt as to the best line to be located. If there are any number of lines of nearly equal value, they can all be presented.

The line from the East will enter the Valley of the Rio Grande, so as to make a feasible connection with any line going West, between El Paso, Mesilla, or Donna Anna, or mouth of the gorge of the Rio Grande above that place.

It is now generally supposed it will enter near Franklin. You had better establish headquarters at some point in the Rio Grande Valley, easiest of communication by mail with East and West, as a base of supplies.

I lay for your guidance the following general instructions:

The chief of party should be an engineer of experience, who has good government, understands handling a camp, can grasp intelligently the country and situation, who has nerve and energy, and will not run at the first Indian scare. He must also have his party so organized that he can leave it whenever necessary to examine the country; and must, by his example, keep his men at work late and early, so as to lose no time in the field.

The First Assistant should be equally as good a man, as the management of the party and development of the country will often fall upon him.

In building the Texas and Pacific Railway, we must have in view its commercial value as well as the engineering qualities of the line.

In New Mexico and Arizona we desire to so build our road so as to control the business peculiar to that region, especially its mining and stock trade.

The party will therefore note carefully the quality and capability of the land, its agricultural, grazing and mineral resources. For the latter a geologist will be obtained to accompany the party. A careful note of the water supply will be necessary, also the extent of the country that can be irrigated, where located, present condition, &c. The character of timber, where located; the character of the streams, whether flowing the year round; facility for bridging, water way, &c., must all be carefully noted.

Particular attention must be paid to the facilities for building the road, the material of every kind used in its construction, and its supply: timber, ties, stone, gravel,—in fact, everything which will be of use in the construction of the line. One of the assistants must keep a diary, noting daily the weather and everything relating to the survey, country, &c., so that it can be intelligently referred hereafter.

I not only want the particular country through which the lines are run, developed and mapped, but by a system of triangulation I want the prominent points, mountains, streams, &c., accurately fixed and mapped, so that, as we advance, we can fix the basis of a general map of the country we explore, filling in the details as determined by our examinations.

The preliminary lines should be run carefully, and the summits run to a grade, so as to show the grade and approximate work to be done on location. With your main party you should run a side party under a chief and one assistant, and two or three men mounted, with a pack train carrying instruments for examining summits.

This party can be used in triangulation, exploring the country north and south of the principal lines, and will often determine the work to be done by the main party; keeping its base with the main party, and returning as often as required by the chief. It will be useful in determining the numerous lines indicating themselves, without placing the main party upon them. It will also enable the main party to advance rapidly and understandingly, and keep them fully posted as to water and best routes for train and camp.

I find that engineers are apt to overlook the necessity of frequent and full reports. They assume it sufficient to see and

judge for themselves of the country through which they travel, and, therefore, neglect to report information, topography, &c., that are often controlling facts in determining questions relating to location and construction.

I desire, as far as practicable, what the surveys determine presented for our consideration. Rough profiles, maps, &c., are to accompany monthly reports, which are to state briefly what is met and overcome. Present the entire country examined either by instrument or *reconnaissance*, so that we can show that the entire capacity of the country has been exhausted.

You will use strict economy in your expenditures; hold your party to a strict military discipline. These instructions are general. You are not confined to them, but can add to them such others as your experience in the country to be occupied may determine.

I enclose orders from the War Department and Military Division of the Missouri for escorts.

The chief of party must give his receipt, and will be held accountable for the property of the Company in his charge, and regular property returns will be made to me at the end of every three months showing the disposition made of the same.

* * * * * * * * MARSHALL, TEXAS, Dec. 4, 1872.

I have instructed Mr. Evans, who has a party near to Fort Yuma, to push on and connect with your party at the Pima Villages, in order to get a line through as quickly as possible, and leaving you with your party to develop the country between Pima Villages and the Rio Grande.

I suppose that on your return by the Southern Line you will examine the route down the Gila indicated in my instructions, leaving somewhere near the mouth of the San Domingo; or you will have demonstrated by the time you return what further examinations we should make.

* * * * * * * * January 2, 1873.

I want you to examine the Southern Line sufficiently to give me a report on it.

I do not think it necessary to run a continuous line, but think a pack party could be run through on it, examining the passes

and getting the distances by odometer and triangulation. I also want you to consult fully with Mr. Hurd when he arrives, and give him such advice of the country east of you as you deem proper. Perhaps it would be well for you to examine, with Mr. Hurd, the line from Mesilla to the head of Blackwater or the Rio Penasco or Felix.

The Guadaloupe range of mountains must have a thorough exploration. This falls under Mr. Hurd's duties, but I would like to have the opinion of both of you upon it.

I am, very respectfully,

G. M. DODGE,
CHIEF ENGINEER.

ENGINEER'S OFFICE,

MARSHALL, TEXAS, June 25, 1873.

GEN. G. M. DODGE,

CHIEF ENGINEER:

DEAR SIR,—The surveys on the New Mexico Division of the Texas & Pacific Railway, completed under my charge, have comprised the following lines:

1st. The main line from Fort Bliss, Texas, *via* the Rio Grande, Florida and Railroad Passes, Arivapa Cañon and the Gila River, to the Pima Villages; distance, 368.3 miles.

2d. The San Pedro Line from Railroad Pass, *via* Nugent's Pass and the San Pedro, to its connection with the main line; distance, 118.56 miles.

2d. The Tucson Line from Sacaton eastward, *via* the Santa Cruz, Tuscon and Cuenega, to Nugent's Pass; distance, 125.62 miles.

4th. The San Simon Line, *via* the San Simon Valley, to the Gila; distance, 139.4 miles.

5th. The Southern Line from the Santa Cruz Valley, running near the Mexican boundary, to a connection with the main line east of the Pyramid Range; distance, 204.86 miles.

THE MAIN LINE.

Commencing at Fort Bliss, Texas, the line runs up the open Valley of the Rio Grande for a distance of about five miles. Here the river narrows up and becomes almost a cañon, it having apparently cut its way through the mountains, leaving rocky, precipitous banks, and is the only place on the river where a rock foundation could be obtained for a bridge; although a crossing here would have to be at a very sharp angle, or a large amount of rock work would have to be done on the approaches. The river runs through this narrow gorge for about one mile; the valley then opens out somewhat, but still the long, flat spurs from the mountains extend out into the valley for a considerable distance, and to avoid the annual overflow we are compelled to cross these spurs with short, undulating grades. After passing these spurs, we have the regular grade of the valley—about four feet per mile—until we reach Station 1697, near the settlement of La Mesa. Here we commence ascending the table-land of the Sierra Madre. This table-land is about four hundred feet above the Rio Grande, and will require a grade of sixty feet per mile for about six miles to reach the plain.

From the top of the Mesa or table-land our line runs nearly due west, with light, undulating grades, and very light work, over the high rolling plain of the Sierra Madre, passing through Florida Pass to the valley of the Miembres, crossing the dry bed of that stream about twelve miles south of the town of that name, on the stage road. From thence, continuing nearly the same course, we pass about twelve miles south of the Ojo de Vaca, or Cow Springs, leaving the Burro Mountains on the north and the Pyramid Range on the south, running just at the foot of the last-named range, and reaching the valley which lies just west of this range, one hundred and twenty-five miles from the Rio Grande.

From the Rio Grande to this point is one continuous plain, slightly rolling, covered with gramma grass, mesquite and soap weeds, with but very few culverts required, and the work and grades all of the very lightest.

Crossing this valley, we encounter the Peloncillo, or

Stein's Peak range of mountains, which extend from the Gila, on the north, in a southeasterly direction, across the boundary line into Mexico. This range was crossed through a low gap about six miles south of the old boundary commission road. An eighty feet grade was used in crossing this summit, but I think that on a location it can be reduced to seventy feet at least, and perhaps to sixty-six feet. The line, after crossing this summit, hugs the side of the mountain, or rather a projecting spur, for a distance of six or seven miles, and then makes directly across the San Simon Valley. For railroad pass in the Chiricahua Range, passing this summit with light work and easy grades, we enter the Sulphur Springs Valley or Valley of the Playas de los Pinos, and follow it for a distance of thirty miles to the head of Arivapa Valley. From thence, bearing a little north of west, we follow this valley for a distance of thirty miles to the head of Arivapa Cañon. This point is 275 miles from Fort Bliss, and is the first place where we encounter any work of importance. This cañon is a close, narrow, crooked cañon, in many places with walls of perpendicular rock from six to eight hundred feet high. The building of the road through this cañon will involve a large amount of heavy rock work, some 2,500 feet of tunnel, and fifteen bridges; also some heavy curvature. The distance through the cañon is twenty-five miles. After leaving the cañon we enter the valley of the San Pedro; thence down that stream to the Gila, and down the Gila to the Pima villages, the terminus of the New Mexico Division.

From the mouth of the San Pedro, down the Gila for a distance of twenty-five miles, we will have some little work, which on this line might be called heavy work. Yet it is of very little importance when we take into consideration the length of our line. Forty-five miles will cover the whole distance on which there is any work of importance, and twenty-five of this is through the Arivapa Cañon. The remaining 340 miles can all be done with ploughs and scrapers.

THE SAN PEDRO LINE

Leaves the main line just west of Railroad Pass, and, bearing a little south of west, crosses the valley of the Plagas de los

Pinos, and makes directly for the Calitro Mountains, a range running parallel with the Chiricahua Mountains, and on the east side of the San Pedro. Crossing this range, through what is known as Nugent's Pass, with a grade of eighty feet per mile, and light work, we reach the valley of the San Pedro, near the settlement of Tres Alamos; from thence down the valley of the San Pedro, connecting with the main line near where the Arivapa empties into the San Pedro; the distance being twenty-six miles longer than by the Arivapa route.

THE TUCSON LINE.

This line was run from the west, leaving the main line twelve miles east of the Pimos villages, near Sacaton, and follows a valley leading into the Santa Cruz; thence up the Santa Cruz about twenty miles to near Picacho Station, thence north of Picacho Mountain, coming into the valley of Santa Cruz near Desert Station; thence up the valley, *via* the point of mountain, to near Tucson; thence up the valley of the Rillito and Cuenega to the pass between the Whetstone and Catarina Mountains, crossing the divide between the Cuenega and San Pedro; thence down the San Pedro, connecting with the main line near Tres Alamos, and just west of Nugent's Pass. The profile of this line presents an almost unbroken surface for nearly one hundred miles, to near the Cuenega, or head waters of Rillito, with very light work and undulating grades from fifteen to fifty feet per mile. On reaching the Cuenega we have a short distance of rough, broken ground, with a grade of sixty-six feet per mile; also, again at the divide between the Cuenega and San Pedro, we have some rough ground, with an eighty foot grade. The work, however, is not heavy, and I think, on a location, the grades might be reduced to sixty feet. Down the San Pedro to its connection with the San Pedro line, the work is all light. From this point east the line will be identical with the San Pedro to its connection with the main line; from thence, the same as the main line to the Rio Grande or Fort Bliss.

THE SAN SIMON LINE.

This line leaves the main line in the valley of the San Simon, and, instead of crossing, keeps down the valley to the Gila,

entering this valley near old Fort Goodwin; thence down through a wide, open valley for about twenty miles, when we enter a close, narrow, crooked cañon, twenty-six miles long, connecting with the main line near where the San Pedro empties into the Gila. The grades on this line are all light, and with the exception of the Gila Cañon, the work is light. Through the cañon we have heavy rock cutting, five or six hundred feet of tunneling, fifteen bridges, and heavy curvatures.

THE SOUTHERN LINE

Was commenced in the valley of the Santa Cruz, south of Tucson, and near the Mexican boundary line. Leaving the Santa Cruz, it follows the valley of the Senoita to its head near Camp Crittenden; thence across a high, rolling country to the head of the Babacomeri; thence down this creek, *via* old Camp Wallen, to the San Pedro; thence running an easterly course across the San Pedro, Dragoon and Chiricahua Mountains to the San Simon valley. Finding no pass through the Peloncillo range, we turn north down the San Simon, crossing through a pass about six miles south of where the main line crossed; thence, *via* Sedenderfer's Wells, connecting with the main line east of the Pyramid Range. This line, in comparison with the others, I consider impracticable. It is much longer, and will require grades of 100 feet per mile, and very heavy work in reaching the summit between the Senoita and Babacomeri, and I think it very doubtful if a line can be made through there without going into Mexico.

WATER.

After leaving the valley of the Rio Grande, there is no water directly on the main line until we reach the Arivapa valley. Across the Sierra Madre artesian wells will have to be sunk the most of the distance. Opposite Station 3,480, and eight or ten miles north, is Cook's Springs, where there is an abundant supply of water, which might easily be brought down to the line in pipes. At the Miembres there is no doubt but that plenty of water will be found by digging twenty or thirty feet. Twenty miles west, we come to a point opposite the Ojo de Vaca (Cow Springs). These springs are about twelve miles north of the

line, and would supply an abundance of water. In the old mining camp of Ralston, in the Pyramid Range, two and a half miles south of our line, they have three wells about forty feet deep, with a good supply of water; and the valley in which this water is found leads directly down to our line, and I have no doubt but that we could reach the same vein at about the same depth. In the valley of the San Simon there is no doubt about finding all the water necessary. If not found at the crossing by digging a short distance, there is plenty of good running water six miles up the valley. From this point on, there is no water supply that can be relied on until you reach a point opposite Mount Graham. In the Chiricahua Range, under the Dos Cabezas, there are some springs, but I hardly think they could be made available. At about Station 12,900, on the main line, opposite Graham, and about eight or ten miles distant, there is quite a large stream that comes down from the mountain, and sinks soon after reaching the plain. Then, again, near Station 13,500, we have Bear or Eureka Springs, and four miles further on, we reach running water in the Arivapa, from which point on there is no lack of water. On the Tucson route, after leaving the San Simon, the first available water we find is at the San Pedro. Twenty miles farther on, we reach the waters of the Cuenega, which form a running stream for about seven miles. From this point west we will have to depend on wells. In the valley of the Santa Cruz, fifteen or twenty feet in depth, I am satisfied would give us an abundant supply of water. On the San Simon line there is plenty of water, all the way from where it leaves the main line to its terminus.

TIMBER.

The valley of the Rio Grande from San Elizario, twenty-five miles below Fort Bliss, to Fort Seldon, twenty-five miles above La Mesilla, receives its supply of lumber from Tulerosa, in the Sacramento Mountains; this is about forty-five miles from La Mesilla. There is said to be a large body of fine timber there, and all our supplies for this portion of the line would have to come from there. A small quantity might be obtained from the Oragan Mountains, within twenty miles; but it could not be depended upon for any amount. The Tulerosa timber

would supply a large number of ties, as well as bridge and building timber. After leaving the Rio Grande, the first timber is found in the Cook's Peak Range, north of Cook's Springs, and about thirty-five miles from the line of the road. From this point on, all the mountains north of the line have more or less timber suitable for ties and building purposes. The Burro Mountains have a fine body of timber on their northern slope, about thirty miles north of the line, and in the Chiricahua Range, twenty miles south of Bowie, on Cochise Reservation, there is said to be a fine pinery. On the Graham, Calitro, Catalina and Santa Rita Mountains there is more or less timber suitable for ties and building purposes, but it would all have to be hauled thirty or forty miles. Fuel for the road would also have to come from these points.

STONE.

Stone for building bridges, culverts, &c., I think will be found within a reasonable distance of the entire line, and in sufficient quantities for all purposes.

COAL.

No discoveries of coal have been made anywhere in the country through which the road will pass. The nearest coal to our line that I know of, is on the Rio Grande, about sixty miles above La Mesilla, near Fort Thorne. The vein has never been opened, and no one seems to know how much there is of it, or of its quality. Some parties were digging for coal near El Paso as I came through there, and claimed to have found coal, but I am inclined to doubt it.

For the geology and mineralogy of the country, I refer you to the accompanying report of J. G. Knapp, who filled the position of geologist to the party, and has made a full report. He has also noticed some of the agricultural portions of the country, and also returns a meteorological report from July 4, 1872, to May 26, 1873.

Profiles and maps of all the lines run have been furnished, and I herewith hand you a table of grades and distances and elevations to different points on the line.

For the cost of the different lines, I would respectfully refer you to the accompanying estimates.

All of which is respectfully submitted,

GEO. WOLCOTT,
DIV. ENG'R, NEW MEXICO DIVISION.

NEW YORK, May 30th, 1872.

J. A. EVANS, ESQ.,
DIVISION ENGINEER:

DEAR SIR,—You will proceed to organize a party for the purpose of developing the country on the line of the thirty-second parallel, between the Colorado of the West and the Harbor of San Diego, California.

The map submitted to you will show the lines explored by the San Diego and Gila River Railway Company.

I desire the mountain region thoroughly developed, so as to determine the best line in an engineering point of view between Fort Yuma and San Diego. The examination for the present is to determine fully, before any location is made, the most direct and feasible line, having in view the commercial as well as the engineering value of the line.

Your experience is such, and your knowledge of what is necessary so thorough, as to require from me no orders in detail as to organization of parties, discipline, camp management, economy, &c.

* * * * * * SAN FRANCISCO, CAL., Sept., 1872.

The line from Los Angelos through San Bernardino and San Gorgonio Passes to Fort Yuma, I examined carefully. Through the pass is a surface line, 100 feet grade, and about as cheap as the Platte Valley Line. West of the pass to Fort Yuma is over a sandy valley country, with light maximum grades, sixty feet to the mile.

East to Los Angelos is some work, but nothing to speak of. It is a very cheap, direct line—there being nothing like it on the Union Pacific Line to compare it with. The line through the Yehatcha Pass has twenty-six miles of as rough work as your line at Cottonwood.

The Central Pacific Line through the Solidad and San Fernando Passes, both of which they must take in getting to Los Angelos, is equally as rough.

You will soon see the Gorgonio, and the problem to solve is: the kind of a line from San Diego to the Pass—can you keep up the coast to the Santa Marguerita River, up it to Temecula, and directly across to San Bernardino?

I am, respectfully,

G. M. DODGE,
CHIEF ENGINEER.

SAN DIEGO, CAL., Feb. 3, 1873.

GEN. G. M. DODGE,
CHIEF ENGINEER:

DEAR SIR,—I herewith submit a report of engineering operations conducted under my charge on the California Division of the Texas & Pacific Railway. The examinations covered by this report extend over a space of six months, from August, 1872, to January, 1873, both inclusive. A single party was placed in the field in July, but the work was only fairly commenced in August, 1872. Since then the country between the Bay of San Diego and the Colorado River has been fully examined; 700 miles of line have been actually run in such a way as to give an estimate of cost, much of which has been over a country where the progress was not more than half a mile per day. In addition to this, *reconnaissances* have been made, distances measured, and altitudes taken over 300 miles of additional country.

For the better understanding of the work, the several lines will be designated as follows:

Line A. Otay Valley Line.
" B. San Gorgonio Pass Line, No. 1, *via* the San Diego River, Murphy's Cañon, Buena Vista, S. Louis Rey, Temecula, Temescal, Riverside and San Bernardino.
" C. San Gorgonio Pass Line, No. 2, *via* the Coast, Temecula, Temescal, Riverside and San Bernardino.

Line D. San Gorgonio Pass Line, No. 3, *via* the Coast, Temecula, Santa Gertrude Cañon and the Portrero of San Jacinto.

" E. San Gorgonio Pass Line, No. 4, *via* the Coast, Temecula, the Laguna, San Jacinto Valley, Box Spring Cañon, Riverside and San Bernardino.

" F. San Gorgonio Pass Line, No. 5, *via* the Coast, Temecula, San Jacinto Plains, Box Spring Cañon, Riverside and San Bernardino.

LINE A.—OTAY VALLEY LINE.

This line has its initial point within the corporate limits of the City of San Diego, and on land to be used as passenger depot grounds. Passing through a portion of the city, occupied to some extent, although not interfered with, by buildings, it cuts off an arm of the bay, thereby bringing the main line within easy access of the ship channel to lands now owned in fee by the Company. So much of the line, whatever course may be taken in getting away from the bay, would be common. Leaving the lands of the Texas & Pacific Railway Company, the line crosses Chollas Creek near its mouth, passes through the National Rancho along one of the streets of National City as surveyed, and with easy grades, good alignment and light work reaches the high mesa land lying between the bay and the mountains.

The section of line above described has been put in with care, and, if adopted, no further location of it will be required. It was thought best to do this, so as to be able to form an idea of how far one line would interfere with property comparatively valuable, as well as to enable the city authorities of San Diego to commence negotiations for right of way.

The line in its progress from the mesa or table-land curves to the left, entering the valley of Otay Creek, the drainage of which it follows to its summit.

For a distance of twenty-seven miles from the initial point, the line is, as above described, on the shore of the bay, on the table-land, and in the Otay Valley. The material is generally drift or alluvium ; easy to move, with the single exception that, at what is known as the bend of the Otay a tunnel of 1,600 feet will be necessary, as well as an expensive crossing of the stream itself.

The material in the tunnel is a metamorphic rock difficult to drill, and so shattered that a tunnel through the point would very likely require lining. The heavy work here is caused by a sharp projecting spur, impossible to avoid by curvature.

At this point (twenty-seven miles from zero) the character of the line changes, from the necessity we are under of availing ourselves of the side slopes of the valley to overcome elevation beyond. This may be considered the foot of the steep gradients on the western slope of the range. From here the line is on the broken slopes of the neighboring hills. On the thirty-first mile a tunnel 900 feet in length will be necessary, the material in which, being granite, can be removed at less cost than the tunnel before described. Unless it should prove so fragmentary as to require lining, it will not be difficult. Nothing but an examination of the profiles can give an adequate idea of the character of the work from where we leave the valley of the creek to the summit of this drainage. The summit, when reached, is broad and flat, making it impracticable to lower it by cutting, and so reduce the gradient.

Otay Summit is the water shed between the Otay drainage and that of the Tia Juana; the Ysidoro or Cottonwood branch of which, a short distance beyond Otay Summit, crosses our direction nearly at right angles, making it impossible, within the limit of economy, to maintain our general course. The line, therefore, hugs the broken hill-side bordering the San Ysidoro Cañon on the west, a distance of six miles, maintaining a level grade, the fall of the cañon for the distance being over 100 feet per mile; crossing the gorge 130 feet above its bed to an equally broken slope on the eastern side of the cañon, upon which slope the line continues to the mouth of Bear Cañon, a tributary gorge, the general direction of which is favorable.

The distance from the crossing of the San Ysidoro to the head of Bear Cañon is twelve and two-tenths miles; difference in elevation, 1,371 feet. The summit of Bear Cañon is not suitable for deep cutting, being broad and flat. We are, therefore, from necessity, obliged to use a grade of 116 feet per mile for the entire distance.

The slopes of the San Ysidoro and Bear Cañons are very broken. The material is granite, either solid or in loose bould-

ers of great size. The profile gives a succession of deep cuttings and high embankments. The character of the work here would make the arriving at an estimate of quantities difficult. The specifications would always be doubtful, and measurement in some sort impracticable.

The summit of Bear Cañon is secondary in character, dividing the drainage of the San Ysidoro from that of Melquaty Creek, both tributaries of the Tia Juana; the latter drainage being carried into the San Ysidoro some eight miles above the mouth by means of Tecate Creek. From the summit of Bear Cañon, easterly, a level grade is used for a distance of 100 miles, while the line is kept on the slope of the hill bordering the Melquaty Valley on the north.

Some actual distance might be saved on this section at a loss of elevation and depression, and by the use of heavy gradients. It is a question, however, if operating distance could be saved. Nothing but a location could determine this. If, however, the line has any claims to the adopted one, the attempt should be made.

From the end of this level grade, gradients approximating the maximum of 116 feet are used to the head of this drainage at Walker's Summit, the dividing ridge between waters flowing eastward to the desert, and those flowing westward to the Bay of San Diego. This summit is in no sense a pass, but the crest of the water shed. Its altitude is 3,870 feet above mean low tide; distant from the initial point 81.62 miles.

From this summit to the desert *via* Carriso Cañon the descent is continuous, the work from the summit eastward differing but little in character from that west of it until the head of Carriso Cañon is reached. This cañon is a deep, narrow gorge, the direction of which is nearly north, and parallel with the cañon of the San Ysidro heretofore referred to, and from which it does not differ materially in character, save that the rock on the slopes of the Carriso is more broken up and fragmentary, the slopes steeper, and the projecting spurs sharper and more numerous. The best line we can obtain down the cañon will require, in a distance of ten miles, eleven tunnels, aggregating in distance 6,755 lineal feet.

The direction of the gorge of the Carriso, being, as stated, nearly north, the first available opportunity is taken of passing through the hills to the east of it by means of a tunnel 1,600 feet in length, which carries the line to the desert slope, which the line follows with variable gradients, some of which are 105 feet per mile. A distance of thirty-one miles from the mouth of the tunnel last referred to brings the line to the level of the desert plain.

For one-third of the distance last named, or say ten miles, the line passes over a smooth slope covered with drift pebbles from the hills, having a substratum of clay, desert and sterile. The course of the line eastward is over the depression of New River, in which basin or depression the grade line falls to thirty-seven feet below our datum line of mean low rates in the Bay of San Diego.

There can be no question but that much of the country passed over by this line, "especially where the soil is of a clayey character," could, by the application of water, be made highly productive.

Some of the country west of the New River basin is covered with a light layer of shifting sand likely to give some, but no serious trouble in operating the road. The mode of construction here would be that of having the road-bed in embankment some two feet above the natural surface, which plan would from necessity be pursued here if no shifting sand made it desirable.

From the crossing of New River (which is nothing more than back water from the Colorado in time of freshets) to the sand hills, the character of the country does not differ materially from it, except that more of the ground is covered with a scattering growth of mesquite timber well adapted for fuel; indeed, on no part of this line can this necessary material for operating a road be had so readily or with so little cost.

The total distance from San Diego to the Sand Hills of the desert is 178 miles. These sand hills, which are impossible to avoid by a direct line from the Carriso Cañon, seem to be an accumulation of drifting sand carried by the prevailing winds from the upper gravelly plain to the desert. They extend from north-west to south-east. Our line *via* San Gorgonio Pass

goes to the north, and barely touches them. They extend across the Mexican boundary line, increasing in altitude and width of base as we follow them from north to south.

There are two ways of avoiding them altogether: first, by changing the direction of the line from where the level plain of the desert is reached, and connecting with the line from San Gorgonio Pass; or, second, by dropping below the boundary line between the United States and Mexico. The former would lengthen the distance from San Diego to Fort Yuma eighteen miles; the latter would not increase the distance materially, but would be in foreign territory for a distance of eight miles.

Total distance from depot grounds at San Diego to crossing of Colorado River at Fort Yuma, 203.11 miles.

TABLE OF GRADES.

	Ascending. Miles.	Descending. Miles.
Between 0 feet per mile and 20 feet per mile.....	35.29	12.39
" 20 " " " " 40 " " "	14.21	8.28
" 40 " " " " 60 " " "	9.67	2.02
" 60 " " " " 80 " " "	6.36	13.32
" 80 " " " " 105 " " "	16.86	28.64
Maximum of 116 " " "	11.68	
Level grade...	.....	44.39

Distance ascending..... 94.07 miles
" descending..... 64.65 "
" level grade..... 44.39 "

Total distance, 203.11 miles.

ESTIMATE OF COST—SECTION NO. 1.

From Depot Grounds to Station 908+70, Foot of Grade in the Otay Valley.

Distance, 26.8 Miles.

541,464	C. yards earth excavation at	$ 32	$178,683 12
53,000	" " loose rock excavation at	1 00	53,000 00
53,000	" " solid " " "	2 25	119,250 00
17,500	" " tunnelling at	14 00	245,000 00
525	" " second-class masonry at	10 00	5,250 00
995,747	Feet, B. M., timber in trestles at	50 00	49,787 35
28,070	Pounds of wrought iron bolts at	10	2,807 00
19,746	" " cast " washers at	8	1,579 68
26.8	Miles superstructure—including iron, ties, laying, &c., at	13,000 00	348,400 00
40,284	Lin. feet piling	50	20,142 00

26.8 miles at $38,205.00 per mile, $1,023,899.15.

SECTION NO. 2.

From Station 908+70, Foot of Heavy Grade, to Station 4,300, in the Carriso Canon.

Distance, 81.57 Miles.

2,970,736	C. yards earth excavation at	$ 30	$891,220 80
943,320	" " loose rock excavation at	1 00	943,320 00
1,907,903	" " solid " " "	2 00	3,815,806 00
220,000	" " " " " "	1 75	385,000 00
116,741	" " tunnelling at	12 00	1,400,892 00
6,156	" " first-class masonry at	20 00	123,120 00
21,830	" " second-class masonry at	12 00	261,960 00
600	Lin. feet of truss bridging at	38 00	22,800 00
7,055,967	Feet, B. M., timber in trestles at	50 00	352,798 35
111,892	Pounds wrought iron bolts at	10	11,189 20
154,012	" cast " washers at	8	12,320 96
81.51	Miles superstructure—iron, ties, tracklaying, &c., at	13,000 00	1,060,410 00

81.57 miles at $113,777.00 per mile, $9,280,837.31.

SECTION NO. 3.

FROM STATION 4,300 IN CARRISO CANON TO STATION 5,300 ON THE DESERT.

DISTANCE, 18.94 MILES.

1,339,850	C. yards earth excavation at	$ 28	$375,158 00
96,073	" " loose rock excavation at	1 00	96,073 00
692	" " first-class masonry at	20 00	13,840 00
5,092	" " second-class masonry at	12 00	61,104 00
962,228	Feet, B. M., timber in trestles at	50 00	48,111 40
18,106	Pounds wrought iron bolts at	10 00	1,810 60
22,722	" cast " washers at	8 00	1,817 76
18.94	Miles superstructure—iron, ties, tracklaying, &c., at	13,000 00	246,220 00

18.94 miles at $44,568.00 per mile, $844,134.76.

SECTION NO. 4.

FROM STATION 5,300 TO COLORADO RIVER AT FORT YUMA.

DISTANCE, 75.8 MILES.

1,094,215	C. yards earth excavation at	$ 25	$273,553 75
62	" " second-class masonry at	12 00	744 00
415,676	Feet, B. M., timber in trestles at	60 00	24,940 56
8,376	Lin. feet piling at	80	6,700 80
10,888	Pounds wrought iron bolts at	10	1,088 80
5,098	" cast " washers at	8	407 84
75.8	Miles superstructure—iron, ties and tracklaying, at	13,000 00	985,400 00

75.8 miles at $17,056.00 per mile, $1,292,835.75.

SUMMARY OF COST.

Section No. 1	26.8 miles	$1,023,899 15
" " 2	81.57 "	9,280,837 31
" " 3	18.94 "	844,134 76
" " 4	75.8 "	1,292,835 75
203.11 miles at	$61,256 00	$12,441,706 97

Total amount of elevation - - - 4,580.8 feet
" " " depression - - - - 4,452.1 "
" " " curvature - - - - 17,864 degrees

The foregoing estimate is based upon a width of road-bed of sixteen feet in cuttings and twelve feet where the work is on embankment. In the side-hill work, more especially in the San Ysidoro and Carriso Cañon, where the deep gulches occur, the estimate is based upon the supposition that we take what excavation there may be in the adjacent cuttings to form a base for trestle-work of timber. In a few cases an amount of borrowed material is estimated, so as to bring the length of posts within 100 feet. In one case, crossing the Cottonwood, or San Ysidoro, four spans of truss bridging have been estimated, making 600 lineal feet. The mode of estimating this line, and the same is true of all the lines, has been this: The line has been estimated in embankment. Wherever the material in the excavation is shown to be beyond a reasonable haul (1,000 feet), that quantity has been added. All cuttings have been classified. On the rocky sections of the work, the foot of the heavy gradient, twenty-seven miles from the initial point, the material in excavation has been assumed to be twenty-five per cent. earth, twenty-five per cent. loose rock, and fifty per cent. solid rock. This classification is believed to be tolerably correct so far as the cuttings are concerned.

The material which it is necessary to obtain for road-bed outside of the cuts proper, technically termed "borrowed," are assumed to be earth; it forms a considerable part of what is termed "earth excavation" in the estimates.

The character of the mountain work and its material on this line is such that it may be difficult to obtain the quantity of earth for the purpose. A large quantity of loose rock may have to be obtained, which would increase the aggregate of the estimate and the cost of the work.

The amount of curvature on this line, 17,864 degrees, is excessive, indicating of itself a very broken country. It will be readily seen, if the total curvature be divided or distributed over that part of the line where it occurs, viz., between the foot of the grade and where the line leaves Carriso Cañon, a distance of eighty-three miles, it will be found to give a curve of four degrees per station. Radius 1,432 feet for that entire distance. Curves of eight degrees and ten degrees will be found necessary on this line in many places, as in Carriso Cañon, and also in

the San Ysidoro. A lateral shift of a few feet would place the line in heavy work, in some cases making a difference of eighty or one hundred feet in the altitude. Nothing short of an actual inspection of the line on the ground can convey an adequate idea of the character of the work. It is safe to assume that no bids by the yard for doing much of this work would be had. There would always be a doubt as to classification, and a difficulty in holding material once disturbed in its place.

In consequence of the rocky character of the mountain section of this line, the grade line has been thrown out of cutting as much as a due regard for economy will warrant; the embankments are therefore heavier to some extent. Much of the heavy embankment is replaced by timber, as is evidenced by the large amount of that material provided for in the estimate.

SAN GORGONIO PASS LINE.

As on the western slope we have several approaches to this pass, it will be necessary to institute a comparison between them, so as to arrive at the best line as to cost of construction and economy of operating.

What is designated in the index as San Gorgonio Pass Line No. 1, starts from the so-called depot grounds at the foot of Spring Street, San Diego, having a common starting-point with the Otay Valley Line. At Old San Diego, distant from the initial point 2.65 miles, we have the starting-point of San Gorgonio Pass Line No. 2; Line No. 1 following the San Diego River for a short distance, thence up Murphy's Cañon, keeping in the interior, crossing the drainage of the Solidad, Penasquitas, San Diegito and San Louis Rey, dropping into the valley of Temecula Creek.

The latter, or Line No. 2, from its diverging point at Old San Diego, hugs the coast as far as the Santa Marguerita Rancho, where the Temecula Creek finds its way to the sea, up the valley of which it runs, connecting with Line No. 1.

In the comparison, we may consider the distance of 2.65 miles as common to both lines.

Distance, Line No. 1, . . 64.5 miles.
" " " 2, . . . 59.3 "

Elevation, Line No. 1,	. . . . .	2,020.6 feet.
" " " 2,	. . . . .	903.6 "
Depression, Line No. 1,	.	1,624.7 feet.
" " " 2,	. .	521.9 "

It will be seen from the above that distance is in favor of the Coast Line—elevation and depression largely in favor of it; and when we take into account that much of the additional elevation and depression on the interior line is surmounted by means of heavy grades of 105 feet to the mile, whereas on the Coast Line no gradient of more than sixty-three feet per mile is necessary, the comparison is greatly in favor of the Coast Line. To make the comparison more complete, the following estimate of both sections is submitted:

SECTION OF LINE NO. 1.—INTERIOR LINE.

DISTANCE 64.5 MILES.

1,369,216	C. yards earth excavation at	$ 30	$410,764 80
315,681	" " loose rock excavation at	1 00	315,681 00
411,541	" " solid rock " "	2 00	823,082 00
14,040	" " tunnelling at	12 00	168,480 00
5,168	Lin. feet piling at	60	3,100 80
3,709	C. yards second-class masonry at	12 00	44,508 00
1,418,967	Feet, B. M., timber in trestles "	50 00	70,948 35
31,615	Lbs. wrought iron bolts "	10	3,161 50
25,674	" cast " washers "	8	2,053 92
64.5	Miles of superstructure—iron, ties and track-	.....	.....
.....	laying, at	13,000 00	838,500 00

64.5 miles at $41,554 per mile, $2,680,280.37.

ESTIMATE OF PART OF LINE NO. 2.—COAST LINE.

DISTANCE, 59.3 MILES.

1,782,891	C. yards earth excavation at	$ 30	$534,867 30
60,721	" " solid rock excavation at	2 00	121,442 00
5,926	" " tunnelling " "	10 00	59,260 00
2,900	" " first-class masonry "	20 00	58,000 00
2,000	" " second-class " "	12 00	24,000 00
77,714	Lin. feet piling at	50	38,857 00
1,840,270	Feet, B. M., timber in trestles at	50 00	92,013 50
63,114	Lbs. of wrought iron bolts at	10	6,311 40
31,248	" " cast iron washers at	8	2,499 84
2,250	Lin. feet of truss bridging at	38 00	85,500 00
59.3	Miles of superstructure—iron, ties, &c., at	1,300 00	770,900 00

59.3 miles at $30,247 per mile, $1,793,651.04.

It is possible that some of the material classified above on "Sec. of Line No. 1" may prove to be soft, loose rock. With our present arrangements of grades, if so, it will not be difficult to lift our grade line out of it. The character of the work along the coast is so favorable that the price attached (thirty cents per yard) is high, and will go far toward remedying any error in classification.

As there is a difference of five and two-tenths miles in distance, a large difference in cost of construction, as well as in cost of operating, all in favor of the coast line, we may discard the interior line altogether.

From the convergence of the two sections last referred to and compared, the line continues up the narrow cañon of Temecula Creek for a distance of 7.26 miles, which distance is necessarily common to all lines approaching the San Gorgonio Pass from the Bay of San Diego. A further description of the cañon will be given hereafter.

At the head of Temecula Cañon we find the second diverging point of lines No. 1 and 2, the first going by way of the Laguna, Temecula Creek, Riverside and San Bernardino to the San Gorgonio Pass, and the latter by a direct line *via* the Potrero of San Jacinto.

Line B, "Gorgonio Pass Line No. 1," being disposed of by the comparison already made, we will now consider Line C, "Gorgonio Pass Line No. 2," as from the head of Temecula Cañon B and C are common.

Lines E and F are but modifications of Line C, the first (E) diverging from it at the Laguna, and connecting again near Riverside, in the Santa Anna Valley; the latter (F) diverging at the head of Temecula Cañon, occupying for a short distance common ground with the direct line (D), and connecting with Line E on the San Jacinto Plains, from whence E and F are identical to point of connection with Line C, near Riverside.

It will be necessary, therefore, to compare, first, lines E and F; secondly, to compare the best of the two with Line C.

Distances are as follows :

Head of Temecula Cañon to Riverside, Line E, - - 47.18 miles
" " " " " " " F, - - 43.61 "

	Line E.	Line F.
Total elevation - - - - - - -	678.5 feet	679.3 feet
" depression - - - - - - -	705 "	753.7 "

ESTIMATE OF LINE E.

From Head of Temecula Cañon to Riverside.

Distance, 47.18 Miles.

357,991	C. yards earth excavation at	$ 30	$107,397 30
73,871	" " loose rock excavation at	1 00	73,871 00
147,742	" " solid " excavation at	2 00	295,484 00
883	" " second-class masonry at	12 00	10,596 00
728	Lin. feet piling at	60	436 80
552,618	Feet, B. M., timber in trestles at	50 00	27,630 90
12,759	Pounds wrought iron bolts at	10	1,275 90
6,756	" cast " washers at	8	405 36
$47\frac{18}{100}$	Miles superstructure—iron, ties, and track-laying, at	$13,000 00	613,340 00

47.18 miles at $23,960.00 per mile, $1,130,437.26.

ESTIMATE OF LINE F.

From Head of Temecula Cañon to Riverside.

Distance, 43.61 Miles.

420,531	C. yards earth excavation at	$ 30	$126,159 30
75,475	" " loose rock excavation at	1 00	75,425 00
150,856	" " solid " " "	2 00	301,712 00
1,699	" " second-class masonry at	12 00	20,388 00
508,702	Feet, B. M., timber in trestles at	50 00	25,435 10
12,022	Pounds wrought iron bolts at	10	1,202 20
6,528	" cast " washers at	8	522 24
$43\frac{61}{100}$	Miles superstructure—iron, ties and track-laying, at	$13,000 00	566,930 00

43.61 miles at $25,633.00 per mile, $1,117,773.84.

ESTIMATE OF LINE C.

FROM HEAD OF TEMECULA CAÑON TO NEAR RIVERSIDE.

DISTANCE, 53.66 MILES.

301,808	C. yards earth excavation at	$ 30	$90,542 40
48,362	" " loose rock excavation at	1 00	48,362 00
400	" " second-class masonry at	12 00	4,800 00
3,128	Lin. feet piling at	60	1,876 80
340,284	Feet, B. M., timber in trestles at	50 00	17,014 20
8,831	Pounds wrought iron bolts at	10	883 10
5,292	" cast " washers at	8	423 36
$53\frac{66}{100}$	Miles superstructure—iron, ties and track-laying, at	$13,000 00	687,580 00

53.66 miles at $15,870.00 per mile, $851,481.86.

	LINE F.	LINE C.
Total elevation - - - -	679.3 feet.	732.35 feet.
" depression - - - -	753.7 "	715.05 "

The comparison here again resolves itself into one of distance and costs, the elevation and depression on one line approaching that of the other very nearly. If the grades were equated on both lines, the distance of 43.61 miles, length of Line F, would be made to approach that of line C, caused by the heavier gradients of the former.

The advantages of this section of line C over the shorter line, are, as seen, a difference in cost of $266,292.00, and the better opportunity it offers for northern connections, as where the line deflects to the right out of the Temescal Valley, the distance to Los Angelos cannot be more than 37 miles. Either line would open up the country bordering the Santa Anna River, and that of San Bernardino.

We will now compare Lines C and D from their divergence at the head of Temecula Cañon to where they converge in the Pass of San Gorgonio:

Distance from Temecula Cañon to Pass Line C, 78.39 miles.
" " " " " " " D, 40 "

	LINE C.	LINE D.
Total elevations - - -	2,414.35 feet.	1,774.4 feet.
" depressions - - -	755.05 "	77.9 "

ESTIMATE OF LINE C.

FROM HEAD OF TEMECULA CAÑON TO SAN GORGONIO PASS.

DISTANCE, 78.39 MILES.

531,808	C. yards earth excavation at	$ 30	$159,542 40
95,665	" " loose rock excavation at	1 00	95,665 00
345	" " second-class masonry at	12 00	4,140 00
3,128	Lin. feet piling at	60	1,876 80
47,258	Feet, B. M., timber in trestles at	50 00	27,362 90
13,912	Pounds wrought iron bolts at	10	1,391 20
8,812	" cast " washers at	8	684 96
$78\frac{39}{100}$	Miles superstructure—iron, ties and track-laying, at	13,000 00	1,019,070 00

78.39 miles at $16,708.00 per mile, $1,309,733.26.

NOTE.—The additional elevation and depression on this line is caused by the secondary summit between the Temecula and Temescal.

ESTIMATE OF LINE D.

FROM HEAD OF TEMECULA CAÑON TO SAN GORGONIO PASS.

DISTANCE, 40 MILES.

839,381	C. yards earth excavation at	$ 30	$251,814 80
95,968	" " loose rock excavation at	1 00	95,968 00
191,939	" " solid " " "	2 00	383,878 00
6,498	" " tunnelling at	10 00	64,980 00
2,724	" " first-class masonry at	20 00	54,480 00
2,574	" " second-class masonry at	12 00	30,888 00
350	Lin. feet truss bridging at	38 00	13,300 00
1,204,000	Feet, B. M., timber in trestles at	50 00	60,200 00
24,623	Pounds wrought iron bolts at	10	2,462 30
17,660	" cast iron washers at	8	1,412 80
40	Miles superstructure—iron, ties and track-laying, at	13,000 00	520,000 00

40 miles at $36,985.00 per mile, $1,479,383.90.

The aggregate cost of the sections last considered differ $169,650.00. To offset this, we have the shorter distance on Line D, with a much better arrangement of grades, as our ascent is continuous from the head of Temecula Cañon to the Pass; whereas on Line C we make the subsidiary summit between the Temecula waters and those of Santa Anna Creek *via* the Temescal.

If grades were equated the difference in operating distance would be further increased. Throwing aside whatever advantages Line C may have in the matter of future connections, we will be quite safe in assuming Line D to be the best in an engineering point of view.

It will be understood that all the lines *via* Gorgonio Pass have a common extension from the Pass to the Colorado river.

I shall now give an estimate of the cost of Line D, from the initial point to the crossing of the Colorado River:

Total distance, from initial point in San Diego to the crossing of Colorado River at Yuma . . 270.34 miles.
Total amount of elevation . . . . . 4,138.7 feet.
" " " depression . . . . . 3,995.9 "

TABLE OF GRADES.

	Ascending.	Descending.
Between 0 feet and 20 feet per mile.....	$63\frac{26}{100}$	$43\frac{65}{100}$
" 20 " " 40 " " "	$32\frac{27}{100}$	$20\frac{30}{100}$
" 40 " " 60 " " "	$10\frac{20}{100}$	$13\frac{85}{100}$
" 60 " " 80 " " "	$7\frac{78}{100}$	$9\frac{63}{100}$
" 80 " " 105 " " "	$13\frac{78}{100}$	$14\frac{65}{100}$
Level.....	.....	$41\frac{7}{100}$
	Total.....$270\frac{34}{100}$	
Maximum grade of 105 feet per mile.....	$9\frac{83}{100}$	$6\frac{37}{100}$

Total amount of curvature 6,354 degrees.

ESTIMATE, SECTION NO. 1.

FROM DEPOT GROUNDS VIA THE COAST TO HEAD OF TEMECULA CAÑON.
DISTANCE 67.08 MILES.

1,812,195	C. yards earth excavation at.....	$ 30	$543,658 50
165,689	" " solid rock excavation at.....	2 00	331,378 00
8,122	" " tunnelling at.....	10 00	81,220 00
2,900	" " first-class masonry at.....	20 00	58,000 00
2,932	" " second-class masonry at.....	12 00	35,184 00
15,000	" " slope wall at.....	5 00	75,000 00
2,250	Lin. feet truss bridging at.....	38 00	85,500 00
77,714	" " piling at.....	50	38,857 00
2,356,908	Feet, B. M., timber in trestles at.....	50 00	117,845 40
74,749	Pounds wrought iron bolts at.....	10	7,474 90
46,434	" cast " washers at.....	8	3,714 72
$67\frac{08}{100}$	Miles superstructure—iron, ties, and track-laying, at.....	$13,000 00	872,040 00

67.08 miles at $33,540.00 per mile, $2,249,872.52.

ESTIMATE, SECTION NO. 2.

HEAD OF TEMECULA CAÑON TO SAN GORGONIO PASS.

DISTANCE 39.98 MILES.

839,381	C. yards earth excavation at	$ 30	$251,814 30
95,968	" " loose rock excavation at	1 00	95,968 00
191,939	" " solid " " "	1 75	335,893 25
6,498	" " tunnelling at	10 00	64,980 00
2,724	" " first-class masonry at	20 00	54,480 00
2,574	" " second-class masonry at	12 00	30,888 00
350	Lin. feet truss bridging at	38 00	13,300 00
1,204,000	Feet, B. M., timber in trestle at	50 00	72,240 00
24,623	Pounds wrought iron bolts at	10	2,462 30
17,660	" cast " washers at	8	1,412 80
$39\frac{98}{100}$	Miles superstructure—iron, ties and track, at	13,000 00	519,740 00

39.98 miles at $36,098.00 per mile, $1,443,178.65.

ESTIMATE, SECTION NO. 3.

SAN GORGONIO PASS TO FORT YUMA.

DISTANCE, 163.28 MILES.

880,598	C. yards earth excavation at	$ 30	$264,179 40
51,000	" " loose rock excavation at	1 00	51,000 00
21,000	" " solid " " "	2 00	42,000 00
1,320	" " second-class masonry at	10 00	13,200 00
4,800	" " slope wall at	5 00	24,000 00
53,650	Lin. feet piling at	70	37,555 00
20,810	Pounds wrought iron bolts at	12	2,497 20
9,845	" cast " washers at	8	984 50
668,078	Feet, B. M., timber in trestles at	70 00	46,765 46
$163\frac{28}{100}$	Miles superstructure—iron, ties and track, at	13,000 00	2,122,640 00

163.28 miles at $15,953.00 per mile, $2,604,821.56.

SUMMARY.

Section No. 1	$67\frac{08}{100}$	miles	$2,249,872 52
" " 2	$39\frac{98}{100}$	"	1,443,178 65
" " 3	$163\frac{28}{100}$	"	2,604,821 56
$23,296 00 per mile	$270\frac{34}{100}$	miles	$6,297,872 73

We have now a full estimate of costs, distances, table of grades, &c., on Line A, "Otay Valley Line," and on line D, which has proved to be the best approach to the San Gorgonio Pass from the bay of San Diego, and can now institute a comparison between them:

COMPARISON.

	Line A.	Line D.
Distance	$203\frac{11}{100}$ miles	$270\frac{34}{100}$ miles
Elevation	$4{,}580\frac{8}{10}$ feet	$4{,}138\frac{7}{10}$ feet
Depression	$4{,}452\frac{1}{10}$ "	$3{,}995\frac{2}{10}$ "
Curvature	17,864 degrees	6,354 degrees
Cost per mile	$61,256 00	$23,296 00
Total cost	$12,441,706 97	$6,297,872 73

TABLE OF GRADES—LINE A.

	Ascending. Miles.	Descending. Miles.
Between 0 feet and 20 feet per mile	$35\frac{28}{100}$	$12\frac{38}{100}$
" 20 " " 40 " " "	$14\frac{21}{100}$	$8\frac{28}{100}$
" 40 " " 60 " " "	$9\frac{67}{100}$	$2\frac{02}{100}$
" 60 " " 80 " " "	$6\frac{36}{100}$	$13\frac{32}{100}$
" 80 " " 105 " " "	$16\frac{86}{100}$	$28\frac{84}{100}$
116 " " "	$11\frac{68}{100}$	
Level		$44\frac{38}{100}$
Total	$203\frac{11}{100}$ miles.	

TABLE OF GRADES---LINE D.

	Ascending. Miles.	Descending. Miles.
Between 0 feet and 20 feet per mile	$63\frac{28}{100}$	$43\frac{65}{100}$
" 20 " " 40 " " "	$32\frac{27}{100}$	$20\frac{30}{100}$
" 40 " " 60 " " "	$10\frac{20}{100}$	$13\frac{85}{100}$
" 60 " " 80 " " "	$7\frac{73}{100}$	$9\frac{62}{100}$
" 80 " " 105 " " "	$13\frac{79}{100}$	$14\frac{65}{100}$
105 " " "	$9\frac{83}{100}$	$6\frac{37}{100}$
Level		$41\frac{02}{100}$
Total	$270\frac{34}{100}$ miles.	

It will be seen from the preceding tables that only in the matter of distance has the Otay Valley Line (A) any superiority over the San Gorgonio Pass Line (D). This is more in seeming than in reality, being more than neutralized by the heavy gradients, additional elevation and excessive curvature of the Otay Valley Line.

If we take an engine weighing thirty nett tons, all of which is placed on the drivers, having cylinders sixteen inches in diameter, with a stroke of twenty-two inches, driving wheels sixty inches in diameter, working with an effective pressure of 105 pounds per square inch of piston, we have a tractive force.

$$\frac{16\times16\times22\times105}{60} = 9{,}856 \text{ lbs.}$$

The opposing force can be resolved into friction of engine, tender and cars, resistance of gravity on inclinations and curvatures. We will assume friction of engine and tender to be 350 pounds; friction of cars, "a mean of several experiments," to be six pounds per ton.

Resistance due to gravity—the formula:

$$\frac{W\times G}{5{,}280}$$

W—weight in pounds. G—grade in feet per mile.

With the data assumed, we find that the engine will move on level grade, 1584 tons.

On a grade of	15	feet	per	mile,	820	tons.
" "	30	"	"		546	"
" "	50	"	"		371	"
" "	70	"	"		293	"
" "	92½	"	"		222	"
" "	116	"	"		182	"

We find, therefore, that a grade of

15	feet	per	mile	for one mile =	1.93	miles of level.
30	"	"	"	=	2.9	" "
50	"	"	"	=	4.3	" "
70	"	"	"	=	5.4	" "
92½	"	"	"	=	7.1	" "
116	"	"	"	=	8.7	" "

If we assume the tonnage from east to west is equal to that from west to east, and apply the ratio, we find the 203.11 miles of the Otay Valley Line to be equal to 782.78 miles of straight, level line. Taking the curvature, 17,864 degrees, and resolving it into a three-degree curve, equal to a grade of seven and one-half feet per mile, we have an additional length of level line of 146.64 miles, making in the aggregate 929.42 miles.

Applying the same process to the San Gorgonio Pass Line (D), we find the 270.34 miles to equal 827.82 miles of level line. Taking, as in the last case, the curvature, and treating the 6,354 degrees in the same manner, we have an additional distance, equivalent to a level line of fifty-two miles, a total of 879.82 miles, or forty-nine and six-tenths miles in favor of the San Gorgonio Pass Line (D).

It may be stated, further, that the method used of reducing the curvature as above, is largely in favor of the Otay Valley Line, as much of it would have to be used in six, eight and ten degree curves, which, unfortunately would occur on its heaviest grades.

No distance can be saved in location on the Otay Valley Line; but rather, as already noticed, an additional distance of eighteen miles would have to be made to avoid the sand hills of the desert.

A distance equal to two miles can be saved in location on Line D, as well as a saving of 100 feet in elevations. This was caused by the manner of making connection of Line D with Line C in the Gorgonio Pass, it is quite evident from an inspection of the map.

SAN GORGONIO PASS LINE (D).

For purposes of description this line may be conveniently divided into three sections.

1st. From the initial point in San Diego along the coast to the Rancho Santa Marguerita.

2d. From the Rancho Santa Marguerita to San Gorgonio Pass.

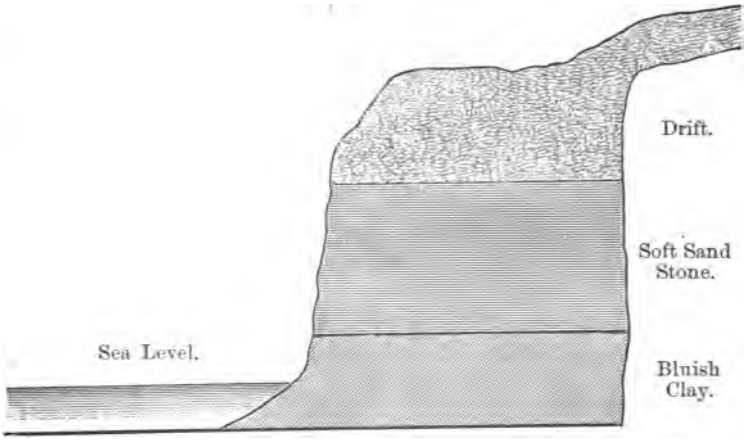
3d. From the San Gorgonio Pass to the crossing of the Colorado River at Fort Yuma.

SECTION 1.

The initial point, as before stated, is identical with the zero of the Otay Valley Line. It passes along the shore of San Diego Bay, with a general direction of N.N.W. to False Bay, the channel of which it crosses where it is narrow, and general depth of water slight, to the western slope of the Solidad Mountain, continuing along that slope, with easy grades and light work, to the depression of La Jolla, a small ravine debouching directly to the ocean.

From this ravine of La Jolla to the mouth of Solidad Creek, a distance of five and four tenths miles, the breakers wash the base of a cliff. The Solidad Mountain putting out a spur seaward for the whole distance, the heavy work on the coast line is mostly confined to this section.

The cliff presents nearly this profile—



Of the 1,782,891 cubic yards of material on this section, full 50 per cent. is chargeable to this distance of less than $5\frac{1}{2}$ miles. It is believed that a better arrangement of grade can be adopted on location than that I have used to make the estimate upon, and a saving made in quantities thereby.

From the vicinity of the Solidad to where the line deflects to the right, entering the Santa Marguerita Valley, the country is favorable in many places; the cliff-like character of the country ceases, being replaced by a slope sufficiently flat so that the line can be placed upon its face, without danger or the moving of much material; and, again, where cliffs do occur, they are surmounted by flat table lands, easy of access, and conforming very nearly to a practicable grade.

Some elevation is lost, from the necessity we are under of dropping into the valleys, viz.: the La Jolla, Solidad, San Diegeta, San Louis Rey, &c.

The maximum grade on this section will not exceed 60 feet per mile.

SECTION NO. 2.

The distance from the Santa Marguerita Valley to Los Angelos, *via* San Juan Capistrano and Ataheim, is estimated to be 74 miles, and the character of the country quite favorable for a railway.

From the Santa Marguerita Valley our line enters the cañon of Temecula Creek. The initial point of this Section (No. 2) may be considered the foot of steep grade on the San Gorgonio Pass Lines. The cañon is ten miles in length, and is caused by the breaking through of the drainage of the Temecula basin, through the Santa Anna Mountains. The gorge is quite narrow in places; in seasons of freshet the narrow channel being occupied solely by the water, as evidenced by marks on the rocks bordering the stream. A mode of construction interfering as little as possible with the water-way, will have to be adopted. A reference to the estimates will show a liberal quantity of slope wall masonry provided for this part of the line.

The amount of work in the cañon is not excessive. The material will prove to be nearly all rock, and it has been so estimated. The grades are not as heavy as is usual in places of similar character, the maximum being 100 feet per mile for two miles of the distance through the cañon.

After leaving the gorge the line crosses the open plain of Temecula, from whence it takes a course directly for the Pass of San Gorgonio. This Temecula Plain is an open valley between the main range and the Santa Anna Mountains. The Temecula Plain and the San Jacinto Plain, both of which our line crosses, occupy the interval between the slope of the San Jacinto Mountains and the secondary range or spur called the Santa Anna Mountains. The direction of the depression of the Temecula Plain is north-west; estimated distance to Los Angelos, eighty miles; all of which is over a favorable country. Forty miles of it would be up a tributary of the Temecula and down the Temescal Creek, the same ground as that occupied by our San Gorgonio Pass Line C.

From the head of Temecula Cañon the line is everything that can be desired for a distance of 24.81 miles, which takes

in the slope of the Temecula Basin and San Jacinto Plains; from thence we follow up a tributary of San Jacinto Creek to what is known as the Potrero. It is on this section that most of our heavy gradients of 105 feet per mile occur, as well as the greater part of our rock work and curvature.

This Potrero, or "pocket," opens out into the Pass of San Gorgonio. A reference to the map will show that Line D tends to the left here, whereas it should bear to the right: this was done for the purpose of connection with the zero of a line starting from the Pass. As a consequence, some two miles of distance is seemingly sacrificed, and about 100 feet of elevation. The altitude of this, the best defined of all mountain passes, is 2,621 feet for line approaching it from San Bernardino, and 2,520 for a line *via* the Potrero. This seeming discrepancy is caused by the pass being triangular, having a drainage eastward to the desert, westward to the Santa Anna River and southward to the San Jacinto. The trend of the summit is, therefore, diagonally across the broad plain of the Pass, dropping off in elevation as the crest is followed south-easterly, which will readily account for the difference of 100 feet in favor of Line D *via* the Potrero of San Jacinto.

It is somewhat remarkable that this, the lowest of all the passes in the range, should be flanked by the highest mountains, having the high peak of San Bernardino to the north, and that of San Jacinto, sometimes called San Gorgonio, to the south of it.

SECTION NO. 3.

From the summit of San Gorgonio Pass, the line commences at once the descent towards the desert. Our profile shows light work, with maximum grades of 105 feet per mile, descending, until the mouth of Coahuila Valley and the plain of the desert is reached. The grades down this slope are valuable and undulating, a constant descent being used. By increasing work and using a uniform grade, a lower rate may be had. This would necessitate a closer adhering to the lateral slopes of the valley, and would increase quantities. As this is a part of the line not examined by myself personally, attention is called to the accompanying report of Mr. J. U. Crawford, the assistant engineer, who made the survey:

SAN DIEGO, February 5th, 1873.

JAS. A. EVANS, ESQ.,

Eng'r Cal. Div. T. & P. Railway.

DEAR SIR,—I have the honor to report that on the 7th day of October, A. D. 1872, the corps of engineers under my charge began our exploration at the summit of the divide in San Gorgonio Pass. We found the summit to be a broad, triangular one, approached by three separate and distinct drainages—one from the west *via* the San Temotes Cañon, a tributary of the Santa Anna River; another from the south *via* the Potrero Cañon, a feeder of the San Jacinto; and a third one from the east *via* the San Gorgonio Cañon, which unites with the White Water drainage. These several systems, forking at their heads into innumerable avogos and washes, made the establishing of the most advantageous summit a matter of some difficulty, and one only to be finally determined upon by the development of the ground by cross levels. This has been successfully accomplished. We commenced by laying a line in an easterly direction, down the San Gorgonio Cañon in the direction of White Water, adhering mainly to the bottom and northern slope of the valley, and obtaining most satisfactory results as to the cost of construction, alignments and gradients.

I found the soil generally to be mixed with boulders and covered with a close undergrowth of cactus and cat-claw brush, among which cattle can find some little pasture. The side-hill, for the greater part, is an even slope, broken occasionally by shallow cross drainage. Some $2\frac{1}{2}$ miles to the north of where our line crosses the summit, lies a ranch owned by Dr. Edgar. This is a well watered and exceedingly fertile estate, prolific in fruit and vines; a fine quality of wine is made at this place and bears the name of the summit. At this point, and adjacent to our line, are some never failing springs, which could easily be made available. Some $5\frac{1}{4}$ miles east of the summit our line passes $2\frac{1}{2}$ miles from Gelman's ranch and Stage Station, at which point a fine running spring would furnish an abundant supply of water, which Gelman freely tenders to the Company in the event of their locating near them. Vandeverter's ranch is situated twelve miles from the summit and a mile north of

the line. Here, also, water can be readily brought to the line. Further on, nineteen miles from the summit, we pass Whitewater Stage Station, leaving it $1\frac{1}{4}$ miles to the north. Here we also find water in abundance. In this case, as is also the same with the others, the spring has a good head and would be self-feeding to a height of fifty feet above the track.

Throughout the San Gorgonio Pass we found any amount of coarse granite rock, suitable for building masonry; while the sides and top of the San Jacinto Mountains, and the ravines which cut deep into the sides of the San Bernardino Mountains, are covered with a thick growth of pine, cedar and oak, which is visible from the line, though apparently rather inaccessible. Upon our arrival at Whitewater Station, I discontinued the survey of the line for the time being, and for a time operated on the western slope in the direction of Temecula, until the 27th day of November, 1872, when the line was again resumed, and pushed on past White River, where I found, for this season of the year, an unlimited supply of water fed from the mountains; when our party passed about mid-day it was running briskly. Our teams went on about three miles, skirting the stream, and pitched camp upon its border. They then began to fill the water barrels of the outfit, when suddenly the stream commenced to die away and sink from their view; so much so that, notwithstanding they closed it up, the party fared poorly for water that night; however, in the morning it was running briskly again. This, however, only occurs when it leaves the side-hill and debouches upon the broad sandy expanse of the Coahuila Valley.

From this point as far as the Cabazon Valley we passed through an arid, sandy, desert region with no vegetation, save an occasional greenwood bush. Avoiding the sand hills, which laid for the most part in a ridge to the south of us, we laid a very direct line, without encountering any obstacles to cheap and rapid construction, to the Cabazon Valley, which we entered some fifty miles south-east from the summit. Here we found the soil to have changed to a rich sandy loam, susceptible of successful cultivation by the aid of irrigation. There appears to be water in abundance, as wherever the Indians have dug for it their efforts have been

rewarded, they always finding it within ten to fifteen feet of the surface.

The whole surface of this valley is covered with a thick growth of mesquite and arrow weed, which in a great measure protects it from the baneful influence of the sand storms which are prevalent here.

The Conia Tribe of Indians live in this valley. They numbered some 1,700 souls when the last census was taken, but have since become reduced in numbers. They are a stalwart, hearty, set of men, and subsist principally upon the mesquite bean and the small game they are able to kill with their arrows, in the use of which they are exceedingly expert.

After leaving this valley, the line passes below tide level, and crosses the northern extremity of the Great Salt Lake of the Colorado Desert. At the place of our crossing, we did not strike water, but skirted it, as the mud was deep and tenacious; after which we crossed a large alkaline deposit, upon large blocks of almost pure salt, from 4 to 6 feet square, and 8 to 10 inches in thickness, tassellated like a pavement and almost correspondingly solid, which passed, we began to ascend, and traversing the southern projection of what had apparently been in ages remote a submerged island of disintegrated sands, stones, shells, a large deposit of gypsum and laminated mica. The slope was cut up in places by subsequent washes and drainage, and was completely bare of vegetation; to our north, and crossing this island, towered abruptly a formidable looking mass—at a distance it resembled the ruins of some dismantled fortress, a close inspection proved it to be a formation of red sandstone rock, evidently the pinnacle around which, in ancient days, the mighty Pacific had boiled and surged; the restless waves had washed great caverns into the very heart of the rock, until they resemble the massive portals of some grim castle. So large were these openings, that into one of them I readily rode my horse. This formation is a silent witness to the fact that, in days gone by, the Pacific claimed all of this country as its own, and is almost the counterpart of the celebrated La Jolla caverns, north of San Diego.

Seventy-seven miles from the summit and 4 miles to the north of us, is the Dos Palmos stage station, upon the line of

the Arizona mail route. At this place there are springs both saline and sulphurous, quite warm and excellent to bathe in, but very poor as a beverage.

Six miles further to the north-east of the stage road brings us to Brown's Gap.

The altitude is as yet undetermined, but in approaching it from the direction of Dos Palmos, the indications are that a line could be obtained upon an unbroken, sustaining side-hill. Ninety-four miles from the summit and 4 or 5 miles to the south, we pass the mud volcanos, five in number. They are found in eruption, alternately and intermittently a cloud of white vapor-like smoke rolls out from their craters, and the constant deposit of material expelled forms, in time, miniature peaks from 30 to over 100 feet in height. Want of time on my part precluded the possibility of a closer investigation of this subject.

Since leaving Cabajou Valley our line has been laid over a dreary, arid waste, not a vestige of either animal or vegetable life; the soil either of a fine alkaline or sandy nature, cut by a drainage which looks in places formidable, but when it is considered how dry and light the dust is, and that the whole surface of the country seems to slide like quicksand mixed with water, and at the slightest impediment washes for itself a new channel through the yielding material, a closer estimate of the requisite allowance necessary for proper drainage can be obtained. Across this desert there is no fresh water after leaving Cabajou, all of the springs are strongly impregnated with salt or sulphur. In order to obtain a supply of fresh water, either artesian wells must be bored or a condenser used.

The water at Dos Palmos is used by both men and animals, and is much more palatable than that at Fink's Springs, which is exceedingly nauseous, but would probably sustain life.

As is seen by the profile, the line passes for a considerable distance below sea level. In addition, it evidently passes across the dry bed of a salt laguna which receives the surface drainage from a large scope of territory, without having any visible outlet. In seasons when there occurs an unusual rain-fall, this basin is liable to fill up more or less. I inquired carefully into this matter, and from the best information I could obtain, I

judge the limits of its rise to be within 5 feet vertical; certain it is, that the stage trail between Dos Palmos and Toros crosses it in the vicinity of the lowest portion, and has never yet been interfered with by overflow. Apart from this, however, it would probably be advantageous to locate the line from Cabajou Valley *via* Palma Soler, Dos Palmos and Fink's Springs, clinging to the side-hill, which is even and seems to invite, and aim to maintian a level grade to connect with the line at the north end of the Sand Hill Range at Sta. 6,000, which is a point we will have to make. This will throw out a rise and fall of 250 feet, but will increase the cost, curvature and length of the line somewhat. After turning the point of the sand hills near Monmouth Tank, our line is laid almost direct to Yuma through a thick growth of Palo Verde, Iron-wood and Mesquite, all dwarfed, bushy trees suitable for fire-wood.

In this neighborhood we also find an abundance of grass which is quite green, and grows in tufts or bunches. This cattle eat with avidity. The formation of the ground is an almost level mesa of stony material, a natural ballast, firmly compacted. The drainage is very light and tends to the south; it seems to sink before reaching the sand hills, which block our course in that direction, rising to the proportions of a formidable looking ridge 150 feet high.

This valley will eventually make fine grazing land if a supply of water can be obtained. There is not a spring or well in it, save the two natural reservoirs, Monmouth and Nigger Tanks, which are situated near the base of the hills, and are simply accumulations of rain-water, caught in the bottom of small scoured out ravines, and is entirely unreliable.

Some few years since the government built a corral and started to sink a well about the centre of this valley. The latter undertaking was abandoned at a depth of 30 feet without achieving any results. I am, however, sanguine that a good supply of artesian water can be had by sinking to a moderate depth.

The only obstacle we encountered between this valley and Fort Yuma, was the descent from the mesa to the Colorado River bottom; this, however, was successfully accomplished by the use of a moderate grade, and crossing these alluvial flats

we reached Yuma upon the morning of the 17th of December, 1872, having traversed 146 miles in 18 working days.

I take this opportunity of bearing testimony to the valuable assistance which I received from my able assistants, Messrs. J. E. Jackson and John A. Evans, and to the uniform energy and cheerful activity displayed by the other members of the corps.

The difficulties with which we had to contend cannot well be over-estimated, and can be only fully appreciated by persons familiar with the locality, or accustomed to desert travel.

I am, very respectfully yours,

JOS. U. CRAWFORD,

ASSISTANT ENGINEER IN CHARGE OF PARTY.

The great features of the desert portion of Line D is its depression below the sea-level; this can be avoided in the manner set forth in Mr. Crawford's Report.

The crossing of the Colorado River at Yuma is common to this line D, and the Otay Valley line. The Colorado River, immediately after its confluence with the Gila, cuts through a projecting spur, which seems to leave an isolated butte on the right bank upon which Fort Yuma is established.

This butte is small in extent, affording just sufficient room for the garrison. Surrounding it on all sides, save that occupied by the channel of the river, is the alluvial bottom land of the Colorado; in season of freshets, it is, in fact, an island.

A line crossing the Colorado River bottom and approaching this elevation for the purpose of crossing the river at an elevation sufficient to dispense with the necessity of a drawbridge, could only do so by means of a long, high embankment, as the uniform level of the bottom land is maintained to the foot of the slope of the butte.

The only thing suitable for the high crossing would be a suspension bridge; the direction would be slightly oblique; the span 500 feet. The objection to a pier will be found in the character of the foundation and the cramped condition of the channel, and its shifting. The bridge site, being but a few feet from the confluence of the two rivers, the channel is some-

times on one side and sometimes on the other—dependent upon which of the rivers may at the time be swollen by a freshet.

As the crossing of the Colorado River cannot be considered fixed until the examinations east are completed, no soundings were taken at the crossing, but there seems to be a considerable depth of shifting material at the bottom of the river.

As before referred to, a crossing of the river better suited to our direction may be found higher up, and a considerable saving of distance be effected.

In concluding the summary for this line, it may be stated that all the available openings suitable for a railroad through the mountains have been examined. The conclusion is irresistible that the best approach from the eastward to the Bay of San Diego, is by way of the Gorgonio Pass and the Cañon of Temecula Creek.

On my arrival at San Diego, in August, 1872, the impression seemed to prevail among those familiar with the mountains east of here, that a more favorable line could be had across the range by dropping into Mexican Territory. So general did this opinion prevail that, during the visit of the president and yourself to this coast, the conclusion to examine it was arrived at.

Before placing a party on the line, which would have required in courtesy permission from the Mexican authorities, I resolved to make a *reconnoissance* of the country, to see if the route was promising, and to obtain such data in the way of altitudes and distances as would facilitate the labors of the party. As several examinations of this sort have been made during the progress of our labors here, I shall designate this as

RECONNOISSANCE OF THE TIA JUANA VALLEY AND TRIBUTARIES.

Starting from the initial point, the ground occupied by the examination is common with that of the Otay Valley Line to nearly the south line of the National Ranche, or where the line turns to the left into the Valley of the Otay; from thence, continuing the southerly course, passing La Punta, we enter the Valley of Tia Juana; continuing up it 4 miles, we pass the national boundary, still keeping in the Valley of the Tia Juana

to the mouth of the San Ysidoro, or North Branch. It will be recollected that our Otay Valley line crosses this same San Ysidoro some distance above. Following up the San Ysidoro for $4\frac{1}{2}$ miles, we find a cañon or gorge.

From our initial point to the mouth of this cañon, is 23 miles by the route traveled. A line 20 miles in length could be had by leaving La Punta to the right, crossing the Mesa, which would prove quite practicable. Indeed, a line of easy grade and light work could be had from the place of beginning to the entrance of this cañon. Altitude of valley at lower end of gorge, 214 feet by barometer.

The distance through the cañon is estimated to be $2\frac{1}{2}$ miles, altitude of upper opening of cañon, 445 feet. The difference in height can be overcome by a grade of 100 feet per mile; or, what would be better, the shorter or Mesa line, could at the cost of additional work, be kept up on the slope, and a lower gradient used to overcome this elevation. Passing this gorge, the Valley of the San Ysidoro opens out, having some extent of bottom land along the margin of the usually dry bed of the stream, for a distance of 5 miles, in which distance we pass out of the Valley of the San Ysidoro, taking that of Tecate Creek for better location.

The ascent of the valley for this distance of 5 miles is 103 feet, making the total altitude 548 feet. At this point the Valley of Tecate Creek ceases and becomes a close cañon, continuing for $2\frac{3}{4}$ miles. The difference in altitude between the opening of the gorge and the upper end, 915 feet, or 333 feet per mile; total altitude, 1,463 feet. This elevation would have to be made by any line occupying the ground examined. Starting from the upper end of the cañon, with its elevation of 1,463 feet, running back towards the Bay of San Diego, with a gradient of 100 feet per mile, would require a distance of $14\frac{63}{100}$ miles, which would take us back to where the line would leave the Mesa, somewhere near the crossing of Otay Creek. I doubt much if sustaining ground could be had for such a gradient. Certain it is that the work would be very heavy, caused by the broken character of the slopes.

This cañon of Tecate may be considered one of the controlling points on this route. From the head of this gorge to near

the head of San José Valley, an affluent of the Tecate, the distance is estimated at 12½ miles, difference in elevation, 1,482 feet, requiring a grade of 118 feet per mile. The profile would be broken, the work very heavy, as it would be necessary to cling to the lateral slopes for the entire distance.

From the head of San José Valley to the summit of the divide, an estimated distance of 18 miles, no difficulties occur. The elevation of summit is 3,580 feet. From thence, this line would pass through a depression leading into the Carriso Cañon, connecting with the Otay Valley line at the head of it.

A line over the ground examined would have no advantage over the Otay Valley line in point of cost—the only superiority would be the saving of 290 feet in the summit.

If the country covered by this *reconnoissance* was under the jurisdiction of our government, and if the question of route lay between the Otay Valley line and this, it would be well to give the ground passed over a more thorough examination.

It is estimated that no saving in distance would be effected by this line over the Otay Valley line.

TABLE OF DISTANCE AND ELEVATION.

Initial Point, San Diego		miles.	16.3	feet.
Crossing of Otay Creek	10	"	25.	"
Barber's Rancho, Tia Juana Valley.....	4	"	80.	"
Bendenas, Mouth of San Ysidoro.....	5	"	160.	"
Cañon San Ysidoro (lower end).....	4	"	214.	"
" " " (upper end).....	2½	"	445.	"
Cañon of Tecate Creek (lower end) ...	5	"	548.	"
" " " " (upper end) ...	2¾	"	1,463.	"
Head of San José Valley	12½	"	2,945.	"
Summit of Divide.....	15¼	"	3,580.	"
Head of Carriso Cañon.....	14¼	"	2,638.	"
	75¼ miles.			

In the examination of railway lines looking to the Bay of San Diego as a terminus, more or less attention has been given to the route *via* Warner's Pass. In the matter of actual distance, a line connecting San Diego with the Colorado River at

or near Fort Yuma, *via* this pass, would rank midway between the Otay Valley line and the line *via* San Gorgonio Pass.

The approach to Warner's Pass from the desert has not been looked upon with favor by engineers who have examined it, *vide* Report of Col. R. S. Williamson, Pacific Railroad Reports, and also A. B. Grey, Civil Engineer.

The only favorable report I am aware of is that of Mr. Chas. H. Poole, made to the San Diego and Gila, Southern Pacific and Atlantic Railroad Company. I have so far been unable to find a copy of the reports *in extenso*. In Senate document No. 5, Session of 1856, incorporated into the Report of the Surveyor-General of the State of California, we find a reference to this report, and a short summary of it, with tables of grades and altitudes, over the signature of Mr. Poole, who at that time was Deputy-Surveyor of San Diego County. I copy a part of the table:

	Intermediate Distance, Miles.	Total Distance, Miles.	Altitude, Feet.
Bay of San Diego			
Capitan Grande, Indian Village ..	$32\frac{3}{10}$		$727\frac{66}{100}$
* Summit of San Isabel.....	$18\frac{87}{100}$	51.17	3,360
San José Valley.....	3.44	54.61	2,768
* Warner's Summit.....	9.27	63.88	3,630
San Felip	10.82	74.70	2,455
* Entrance of Cañon	8.05	82.75	2,638
Great Lagoon	51.75	134.50	70
Mouth of Gila	66.00	200.05	180

The manner of making the examination, which I believe was instrumental, seems to have been a line run in the lowest part of the several valleys, viz., up the valley of San Diego River to the mouth of Oakwood Cañon, up that drainage to the secondary summit of Santa Isabel. In the table, of which the foregoing is an abstract, actual grades are given of 171 feet, 181 feet, 254 feet, and 452 feet per mile on the western slope; from the information thus obtained a deduced grade of best observed location is obtained of 107 feet per mile. The secondary summit of Santa Isabel, which separates the drainage of the San Diego River from that of Warner's Pass, which flows into the San Louis Rey River and the San Bernardo, is a controlling

point as to grade, assuming that the summit can be lowered by cutting 40 feet, making the elevation of grade 3,320 feet; a gradient of 100 feet per mile would have its footing some 6 or 7 miles down the Indian Village of Capitan Grande, and would require to be continuous for 26 or 27 miles. As this would be side-hill work for the entire distance, and over broken slopes cut up by deep lateral ravines, they would be in character similar to that on the Otay Valley line.

It is quite evident from Mr. Poole's table, and corroborated by our own examinations, that the natural approach to Warner's Pass is not by the drainage of the San Diego River, but rather by the San Louis Rey,

The summit of Warner's Pass is given by Mr. Poole as 3,629.56 feet. Colonel Williamson gives the altitude as 3,780, which nearly agrees with our observations in the vicinity. As the latter are barometric and the former supposed to be obtained by actual survey, it is presumed to be the most correct.

A line *via* the San Diego River and Warner's Pass would give a greater amount of elevation and depression than our Otay Valley line, caused by the Santa Isabel summit on the western slope, and the San Felip summit on the eastern, both of which are additional and unavoidable. Reports having reached me of a summit north and east of Warner's Pass, which promised an opening to the desert, I instructed Mr. A. P. Wood, Principal Assistant Engineer, to examine it and take with him a guide who, from having lived in the vicinity, was supposed to have an accurate knowledge of the country. Mr. Wood's report is submitted. It will be gathered from it that the proper and natural outlet to the coast from Warner's Pass and also the pass which he examined, is *via* the drainage of the San Louis Rey River, which would dispense with all secondary summits, and give a continuous descent from the summit to the sea.

J. A. EVANS,

ENG'R CAL. DIV. T. & P. RAILWAY.

DEAR SIR,—I herewith submit a report of an examination made by me, according to your orders of Oct. 20th, 1872, of a pass in the Sierra Nevada Mountains, situated at the head of

the San Louis Rey River, and about 2 miles north and 5 miles east of Warner's Pass; also of the country east of the pass leading down to the desert, and from the same point westward, down the valley of the San Louis Rey River to the ocean, with a view of ascertaining its practicability as a railroad route.

I reached the neighborhood of the pass on Oct. 28th, accompanied by John Warner as guide. The pass is a gap from 3 to 4 miles wide, the mountains rising abruptly on either side. The surface of the country is smooth, gradually ascending from the west to the summit, where I found, by barometric observation, the elevation to be 5,900 feet. At the north of the pass the descent eastward is, in many places, precipitous. By an observation taken on an arm of the desert, I found the fall to be 3,000 feet in a distance of 7 miles.

On the north side the pass leads into a cañon, which I followed to where its drainage enters San Felip Creek at the lower end of San Felip Cañon. The distance from the summit of the pass to this point we estimated to be $10\frac{1}{2}$ miles. The descent in the first $2\frac{1}{2}$ miles from the summit is 710 feet; in the next 3 miles it is 775 feet; and from thence, for a distance of 5 miles, 130 feet per mile or 650 feet. This rapid descent of the cañon would necessitate keeping a line on the side of the mountain. On the side of the mountain separating this cañon from the San Felip Valley, I think sustaining ground can be found for a line of practicable grades and curves.

Though I am of the opinion that a grade of 116 feet per mile from the summit would necessitate crossing a low place in the mountains into the valley of the San Felip, and to get out of this valley with a line of the same grade, a line would have to follow the mountains back in the direction of Warner's Pass for some distance, and thence bear south and east along the mountains on the south side of the valley.

This would involve a great amount of curvature, and the work would be of a *very heavy character*, as the sides of the mountains are cut up by deep lateral cañons and sharp spurs composed of solid rock. The surface of the country is covered with granite rock, which appears to be rapidly disintegrating. There is scarcely any growth of vegetation here.

From the summit of the pass, westward, down the valley of the San Louis Rey, I found an entirely different country. According to barometric observation, the descent does not exceed 100 feet per mile for any part of the first 15 miles from the summit, west. The country is a smooth valley, varying in width from ¾ to 3 miles, and well watered.

At this point the stream leaves the valley of Warner's Pass, and enters San José Cañon. In a distance of 16 to 18 miles, this cañon descends 1,720 feet. The side of the mountain, to the south of the stream, is comparatively smooth and favorable for the construction of a railroad.

After leaving the cañon there are no difficulties in the way between that point and the ocean, as a line would follow the valley of the San Louis Rey. Good alignment can be had from the summit to the ocean. The course of the stream is from east to west, and it is comparatively free from sharp angles.

There is a good supply of timber for fuel—not for other purposes—on the sides of the mountains, from the summit to the mouth of San José Cañon, and an abundant supply of good water from the summit, west. I found a few springs of pure water on the desert side, though I doubt the supply being sufficient for railroad purposes.

Respectfully yours, &c.,

A. P. WOOD,

PRIN. ASS'T ENG'R.

It would seem, from the examinations of Mr. Wood, that the pass, north and east of Warner's Pass, is less advantageous than Warner's, as in making the descent from it towards the desert, it would be necessary to make the *detour* back into the valley of the upper San Felip, and surmount the secondary summit between the drainage of San Felip and the Carisso. It would seem, by comparing authorities, that the summit is higher than that of Warner's Pass. It is presumed, further, that the line indicated by Mr. Poole would exceed in elevation and depression, as well as in distance and grade, the Otay Valley line; it need not, therefore, be used in a comparison with our northern lines, *via* the San Gorgonio Pass.

The openings or passes in the range east of San Diego, may be summaried as follows:

Name of Pass.	Altitude, Feet.	Natural Approach to.
1. San Gorgonio.....	2,521	Coast Line, Temecula Cañon and Potrero of San Jacinto.
2. Warner's Pass	3,630	Coast Line and San Louis Rey Valley.
3. Pass near Warner's.....	3,900	" " " "
4. Volcan Pass.....	3,850	San Diego River and Tributaries.
5. Head of Pine Valley	4,700	Otay Creek and Cottonwood Valley.
6. Walker's Summit.....	3,870	Otay Creek, Bear Cañon, and Melquate Creek.
7. Los Huntos'Summit, Mexico	3,580	Tia Juana Valley, San Ysidoro and Tecate Creek.

The impracticability of the summits 4 and 5 consists largely in the difficulty in reaching the desert, the direction of the descent being directly east, and not parallel with the direction of the range, as is the case with the approach to Warner's Pass and Walker's Summit.

TERMINUS OF SAN DIEGO.

The Texas and Pacific Railway Company has acquired title to two leagues of land, in the vicinity of the bay, 700 acres of which lies in a compact body, contiguous to the best and most accessible part of the ship channel on the eastern shore of the bay. This tract is conveniently situated for the location of depots and shops, requiring little or no grading for that purpose.

By reference to the map it will be seen that a spur line from our line D, diverging near Old San Diego, would make available for business the basin inside of Ballast Point, and in front of La Plaqua. This spur will cost but little to grade, and if required, dockage could be made there with little expense, so as to place cars within reach of ship tackles.

It may be mentioned as one of the advantages of the northern line, that all approaches to it from any point of the bay will prove to be simply extension of line, as opposed to lengthy *detours.*

In conclusion, I beg to refer to the valuable aid received from Mr. A. P. Wood, Principal Assistant, upon whom has devolved most of the labor of preparing the estimates, and to Mr. J. U. Crawford, by whom much of the labor of developing the

line *via* Gorgonio Pass, was performed. That we are able to give results so soon is due in no small degree to the activity displayed by him in his allotted part of the work, and to Mr. C. J. Fox, who also developed some of the most important lines leading to San Gorgonio. Mr. Fox's labors were conducted with great care, and whatever part of them may be adopted, much labor will be saved in future location.

To Mr. J. H. Reno, upon whom devolved the most difficult and discouraging part of our surveys, much credit is due. In the month of July, 1872, he managed to keep the party together under difficult circumstances, although not then in full charge of it.

From Mr. C. P. Taggart, to whom I was referred to for advice in all legal matters, I have received valuable assistance and counsel.

Respectfully submitted,

JAMES A. EVANS,

ENG'R CAL. DIV.

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